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An activity theory analysis of Korean secondary vocational education curriculum: A case study of Electronics and Media Meister high school

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Abstract

This study critically analyzes the Korean secondary vocational education system known as Meister high schools with activity theory. By focusing on the main subjects of Meister high school education—teachers and students—this qualitative case study examines how the Meister high school education is implemented. As part of the data-collection process, the researchers conducted in-depth interviews with, and participant observations of, four teachers and four graduates from a public electronics Meister high school 'A' and a private media Meister high school 'B'. The findings reveal that, while a Meister high school education does improve students' technical and practical skills, the fixed and pre-planned programming of a Meister education contains structural contradictions in terms of developing well-rounded, skilled and employable graduates. However, students and teachers strived to resolve the contradictions by using informal mediations and by reconstructing their curricula, continually adapting and seeking to improve the kind of education offered in Meister high schools. Based on these results, this study provides meaningful implications of secondary vocational education and offers these results as recommendations to this educational system's continued improvement.

Keywords: Korean Meister high school, secondary vocational education, activity theory, contradiction, vocational education curriculum

Introduction

Young Korean people with a high school diploma often struggle to find a job. Indeed, Korea, a highly credentialism-centered country where 70% of people aged 25 to 34 have a college degree (OECD, 2017), has seen its vocational education market spiral into depression. Secondary vocational education in Korea has suffered an identity crisis owing to its graduates' low employment rate when considered in comparison to the high acceptance rates to colleges and universities. Students who have graduated from secondary vocational schools in Korea often fail to embark on a career path upon graduation, and instead choose to attend college without significant forethought as to what they hope to learn in university and how it can prepare them for a career. Such a pattern is due in part to a reduction in the number of suitable jobs for the graduates of vocational high schools, as well as from these graduates being treated poorly in the job market due to negative bias against vocational schools in a country that places more value on the credentials of a university degree. The deterioration of employment conditions and an uncertain professional environment has resulted in Korea producing masses of highly-educated young people, while appropriate job openings have failed to keep pace. Today, the unemployment rate of young people is increasing, even as companies struggle to obtain the technical manpower they require to meet industrial demand.

The Korean government is trying to boost the employment rate of vocational high school graduates (Ministry of Education, 2010). One example of the government's efforts is the establishment of the Meister high school as the specialized secondary vocational education institution in Korea, with the curriculum of each Meister high school tailored to meet industrial demands. It is a trial effort to promote the development of professional vocational education under the Korean government-initiated Plan of Korean Meister Nurture. The aims of this plan are to resolve the chronic problems that have characterized vocational education in Korea, to strengthen the superficial linkage between schools and industry, to mitigate against the phenomenon of students blindly entering university without prior preparation, and to generally establish a new role model of a vocational high school (Ministry of Education, 2008). Meister high schools aim to meet the demands of industry and to break down the negative perceptions of vocational education. Above all, in establishing the Meister high schools, the government has reformed educational regulations by allowing the schools' autonomy in carrying out their curriculum and administering textbooks. The government continues to strengthen its support of Meister high schools by supporting tuition waivers and establishing scholarships and by providing training for advanced vocational schools abroad (Kim, Jang, & Byun, 2009). Meister high schools in Korea have stronger and more explicit educational goals than ever before because their administrators recognize fully the core issues that have typically characterized secondary vocational education. It is worth noting that the will of the government and the interests of the industry are also enmeshed in the success of these schools.

As a part of government policy, Meister high school education has been discussed based on the opinions of the government and policymakers (Jang, Kim, & Min, 2010). The curricula of Meister high schools have been developed with input from the professional sector and various other experts to reflect the knowledge, skills, and attitudes required for working in industry today (Jang, Kim, Choi, Kim, & Lee, 2011). In other words, the Meister high school curriculum has been developed through a top-down approach of centralized

decision-making. However, the actual operational methods of vocational education are determined by the teachers who organize and implement their educational programs, and the final results of the programs' effectiveness come from the students themselves (Billett, 2011).

Unfortunately, however, the discussions dealing with Meister high school curriculum have been excluding the main actors involved in making these schools work at all: the students and their teachers. Indeed, in current discussions, these primary subjects of Meister high school education tend to be disregarded. Moreover, most reports on Meister high schools are limited to merely a descriptive explanation of each school, indicating its present conditions and performance statistics (Ministry of Education, 2013). These documents only focus on short-term achievements, and, as a result, they do not even begin to resemble or approach much-needed discussion on the long-term development of vocational education in Korea. Accordingly, there has been a lack of in-depth, interpretative research into how Meister high school curricula are implemented and developed by the schools' students and teachers themselves, the main subjects of Meister high schools.

Therefore, this study, by focusing on the main subjects of Meister high school education, its teachers and students, critically examines how Meister high school education is pragmatically implemented in Korea today. The study aims to highlight new directions for vocational education to increase its effectiveness. The researchers analyzed the educational activity systems of two Meister high schools—one focusing on electronics, and one dedicated to media—using activity theory. Drawing on the concept of contradiction in the activity system, the researchers closely examined each school's curriculum. In examining how the contradictions faced by teachers and students are resolved in their daily activities at school, the researchers identified the development process of Meister high school curricula in their real-world and real-time contexts, and also suggest new directions to be taken by secondary vocational education in Korea.

Literature reviews

Education in Meister high School

Korean vocational education has long focused on producing skilled workers who can facilitate the country's economic development. Rather than training superior skilled technicians, vocational high school has continued to focus on supplying the workforce with rudimentary laborers. In the 1990s, as industrial development increased, the vocational and technical education policy originally centered on vocational high schools was moved to the university—higher (tertiary) education—level (Chang, 2006). With this shift, vocational high schools, being no longer the preferred system of vocational education in Korea, began to experience significant difficulties. As a result, the students at these high schools began increasingly to enroll in university after high school, rather than enter the workforce. This change may be attributed to a host of factors, such as a decline in the school-age population, the withdrawal of students from vocational high schools, the expansion of universities, changes in student preferences, and a greater prevalence of ambition among young people to obtain a college education. In 2008, the university enrollment of vocational high school students measured 72.9 percent (Statistics on Korean Education, 2008). This may

be attributed to the uncertainty of employment after graduation from vocational high schools, shaped by the superficiality of school-industry linkages and the avoidance by corporations to recruit employees directly out of high school due to the country's mandatory military service. Additionally, because of inferior treatment in the workforce—including being underpaid, working in poor conditions, and experiencing prejudice—vocational high school students often choose instead to blindly attend university without consideration of what education or career they will pursue with it (Ministry of Education, 2008).

In response, the government developed the Korean-style Meister high school. Their objective was to enhance the response of vocational education to industry demands, and to enable students to become specialists in a desired field. The new government, voted into office in 2008, selected high-quality vocational high schools to trial their plans to enable career development through secure employment and allow vocational students to obtain qualifications in the workplace. These schools were fashioned as Meister high schools, and upheld as models for the future development of vocational high schools in Korea. The core contents of the government's Meister high school promotion plan are largely composed of the establishment of a "Meister" career path, regulatory reform for Meister high school student talent development, and national fostering and support (Kim et al., 2009). The Meister high school, with 21 of them launched in March 2010, is tailored to industrial demand. Its purpose is to operate a customized curriculum that is directly related to the demands of its corresponding industry (Enforcement Decree of the Elementary and Secondary Education Act, Article 91-2). The purpose of a Meister high school is to promote the competitiveness of local industry and to advance its technological capacity by cultivating the best professional technical personnel in the local employment pool (Park & Jo, 2011). As of March 2018, Korea operates 47 of these schools.

Following the government's Designation and Governance Orders of Special Purpose High School, each Meister high school curriculum should be tailored to the needs of its corresponding industry so that its students are being educated appropriately. If necessary, the curriculum can be organized and operated autonomously in each Meister high school, separate from the general education curriculum proposed by the Ministry of Education. The key part of the government's Strategy for Designating and Promoting Meister High Schools is to implement customized education by fully liberalizing the curriculum and textbooks through regulatory reform. Therefore, the national common basic education curriculum can be reduced by half, and vocational training and seasonal semesters may be brought in instead. Also, it is possible to develop and utilize specialized textbooks (including handouts, electronic files) at any time (without official approval) and to use educational programs in industries.

The basic direction of the curriculum development in a Meister high school is to tailor the curriculum to the demand of the relevant industry using job analysis. The general curriculum development process occurs as follows. First, an industry-academy consultation body is formed based on industry needs. Next, the necessary educational targets are clarified through job analysis, and, with this information, the consultation body then considers whether it is necessary to partially revise the existing curriculum or to establish an entirely new curriculum (Kim, Park, Jang, Jung, Jeong, & Park, 2011). The evaluations by industrial experts on curricula developed through this process shows that it accurately reflects the technological skills and knowledge required in the industrial field (Kim, Jang, Choi, & Huh, 2012).

As such, the Meister high schools have stronger and more explicit educational goals than vocational schools in Korea ever had previously. Administrators recognize key issues in Korean secondary vocational education and have the encouragement and ability to try to integrate the will of the government with the interests of industry in the development of each school's curriculum and educational goals. The overall process is structured at the national level, and may be described as industry-led. That is, the vocational curriculum of each Meister high school is driven by a top-down approach, one that reflects the strong demands of both government and industry.

The Meister high school policy has so far been generally regarded as successful. Since its first class of graduates from Meister high schools in 2013, the employment rate among graduates each year has been over 90%, indicating an outstanding outcome of the government's efforts to improve the employment rate of vocational high school graduates (Bae, Choi, & Chang, 2013; Bae, Oh, & Park, 2012; Kim, Youn, Kim, Hwang, & Hwang, 2015; Park & Jo, 2011). However, Meister high schools are currently facing a new challenge: a reduced demand in the labor market caused by an economic downturn, as well as changes in required competencies and to industrial environments in light of the fourth industrial revolution. Meister high schools should respond to the demands of the labor market and changes in industrial society (Kim, Kim, & Kwak, 2017). The curricula of Meister high schools are thus continuously being affected by changing industrial demands and labor market conditions. For the schools' continued growth and development, they must prepare a flexible education system that can appropriately anticipate and respond to the changing needs of industry.

Here we turn to a critical analysis of how these schools' curricula are developed and put into operation. This can be identified through the voices of the teachers and students, who actually operate and experience the vocational education courses in Meister high schools. The stories they share reflect the environment and culture of Meister high schools more accurately and insightfully than what is recorded in government reports. Furthermore, most published empirical studies attending to Meister high schools tend to focus on the relationship between learning outcomes and the psychologic and emotional experiences of the students and teachers in the schools (Bae, Jang, Lee, & Cho, 2014). These studies focus in particular on students' adaptations to school life, their satisfaction with it, and their level of preparedness for their careers. The performances of Meister school teachers are also frequently discussed (Hahm, 2016; Kil, Baek, & Yang, 2018; Yoo & Lee, 2016). Even though these studies amply demonstrate the current situations of Meister high schools, they have limitations: it is not reasonable to expect to collect and analyze insightful information of the schools using only quantitative data. Therefore, by examining and interpreting the interactions and dynamics within Meister high schools' student-teacher communities and reviewing their practical operating situations from the personal perspectives of their students and teachers through qualitative data analysis, this study presents a new approach to the topic of Meister high schools to advance current scholarly discussions.

The characteristics of Korean vocational education and curriculum

One of the most outstanding characteristics of Korean vocational education is that it is organized and provided from top to bottom (Billett, 2011). This method, the main way of organizing the Korean vocational education course, makes the development and

implementation of the curriculum more standardized, and links national unity and policy goals to youth education through the strong role of the government in defining curriculum directives. The result of this is a narrow, specialized, and conservative curriculum. This process does not foreground the benefits of vocational students as learners whose educational experience is limited to their high school vocational training. Top-down directed vocational education in particular can become disengaged from its intended context because of the gap in understanding and responsivity between the government-set curriculum and the skills and technology training that rapidly-changing industries actually need in their workforce. Moreover, since the top-down approach in vocational education does not easily match the needs of its learners, it is difficult for them to obtain the skills that are actually necessary to work in their desired field. Previous studies on this question point out that the dissemination of the government's education curriculum raises problems such as a lack of teachers' understanding of the curriculum, a lack of professional knowledge in the curriculum, and the gap between theory and practice, because of the separation between the curriculum's developers and its users (Saber, 1991, 1994; Skillbeck, 1984). The purpose of this study is, therefore, to examine how the vocational education curriculum is put into practice through close attention to the experiences and choices of the teacher (the subject implementing it) and the student (the subject experiencing it).

Theoretical framework: Activity theory

Activity theory is effective in identifying diverse and dynamic processes of human learning systematically, and to analyze learning from a sociocultural perspective. Taking a sociocultural perspective on learning, activity theory goes beyond the traditional understanding of learning as merely cognitive change or behavioral development by concretely illustrating human learning in diverse situations within a systematic framework. With its systematized and powerful framework for analysis, activity theory casts the changing and dynamic interactions in reality as "extended learning" (Engeström, 2008). For this reason, activity theory is a useful tool to analyze human activities, such as classroom activities in a school and various curricula, and to understand how learning occurs in the collaborative environment of the conventional education arena (Park, 2019). By taking activity theory as its theoretical framework, this study focuses on examining how the vocational curriculum is carried out in practice. As such, the activities of the main actor in Meister high schools—their teachers and students—were the focus of this study. Activity theory clearly shows how the process of Meister high school education performs within its concrete and grounded framework, and provides useful insights that quantitative data alone cannot capture.

To describe the way human beings learn and develop, activity theory employs the concept of activity. As a unit of analysis, the concept of activity is defined as relations with other people and with the natural world. Activity theory emphasizes the interaction and history of various artifacts and regards socio-material artifacts as a major tool for delivering knowledge (Fenwick, 2010).

Activity theory was presented by Engeström as an extended action system model with social and collective elements added to basic human activities. According to the model suggested by Engeström, human activity consists of seven elements—subject, object, tool,

rules, community, division of labor, and outcome. Subject, mediator, and object—located above the triangle in the human activity system model—describe personal activities. Rules, community, and division of labor—located below the triangle—describe the relationship between the individual and the collective activity system (Engeström, 2015).

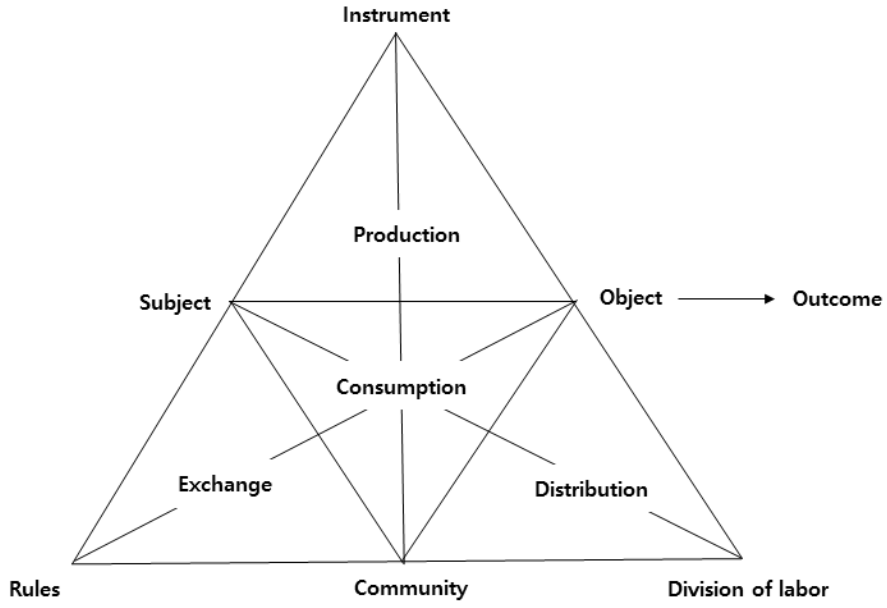

Figure 1. The structure of human activity

Source. Engeström, 2015, p. 63

Subject refers to an individual or group participating in an activity. Object refers to the underlying goal or entity that leads to the activity. Tool signifies mediating artifacts such as tools or signs that mediate or arbitrate the subject acquisition of the object. Rules refer to explicit or implicit laws, norms, customs, and so on. Community means a large number of individuals or groups of them who share the same objective in carrying out an activity and participate in the activity together with related interests and goals. Division of labor indicates a horizontally-divided task shared among members of the community or among various participants of the activity, and the roles and responsibilities that are vertically divided by power and status (Dochy, Engeström, Sannino, & Meeuwen, 2011; Engeström, 2015).

Activity theory analyzes learning at the group level and shows the process of extending and expanding learning through the concept of contradiction. The concept of contradiction in the activity theory proposed by Engeström is at the core of the theory's effectiveness. The contradiction is a conflict between two or more elements in an activity system, which is understood as historically-accumulated structural tension inside an activity system or between activity systems. Internal contradiction occurs when an element causes a change or development that deviates from the operating principle of another element, which is caused

by interaction with other systems of the activity, or by the influence of other activity systems (Engeström, 2008). The contradiction between activity systems is solved by a new mediating tool or a new activity system, even as new contradictions may arise. This may lead to repeated solutions through the generation of a new form of knowledge. New knowledge is created by a continuous resolution of contradictions (Tsui & Law, 2007). As such, contradiction plays an important role as a major source of change to and development catalyst of action systems (Engeström, 2008). Contradiction, while causing obstruction and conflict, also allows innovative attempts to develop an activity (Engeström, 2008). When these conflicts are sufficiently expressed among the members, expansive learning can occur through continual adjustment and negotiation (Fenwick, 2010). Existing power relations and new interests are challenged by the concept of contradiction, and the process of resolving these conflicts may be described by the concept of expansive learning.

Method

Participants

The researchers conducted a qualitative case study with teachers who had implemented the government's Meister curriculum in the field of secondary vocational education, and graduates who had completed that Meister education curriculum. Through purposeful sampling, the researchers gathered a total of eight participants. Four of them are teachers who teach specialized vocational courses at either Meister high school "A" (Electronics Meister high school) or "B" (Media Meister high school) (opened in March 2010); the remaining four are of the first class of graduates from both "A" and "B" Meister high schools. Both the electronics Meister high school "A" and the media Meister high school "B" are located in metropolitan areas, making access to them easy. The electronics Meister high school "A" is a public coeducational school, and the media Meister high school "B" is a private girls' school. One of the researchers contacted the two schools directly so that the contents and characteristics of the vocational curriculum could be reflected well. Both schools recommended two of the teachers currently teaching major courses, and these teachers were willing to participate in the research. The characteristics of the teachers participating are shown in Table 1.

Table 1. The characteristics of research participants: Teachers

Name	School	Subject	Work experience	Gender
Kim	A	Electronic control	17 years	Male
Lee	A	Information technology equipment	5 years	Male
Park	B	New media	7 years	Male
Choi	B	New media solution	10 years	Male

To select the graduates participating in this research, the researchers solicited recommendations from the major subject teachers. The researchers selected graduates who

were currently employed by companies after graduating from the Meister high school and who were willing to participate in the interviews. They are all the first graduates of either school "A" or school "B" and are new employees who have worked for a company for less than a year. The selected graduates are two male students and two female students, and each had different educational majors while attending school. The characteristics of the students are shown in Table 2.

Table 2. The characteristics of research participants: Students

Name	School	Major	Year of graduation	Gender
Cha	A	Electronic control	2013.02	Male
Han	A	Information technology equipment	2013.02	Male
Yi	B	New media solution	2013.02	Female
Woo	B	New media design	2013.02	Female

Data collection

Data was collected through semi-structured interviews, participant observations in classes, and archival analysis. The main method of data collection was the semi-structured in-depth interview. One of the researchers conducted interviews and observations of class participation for approximately two weeks. Before starting the interviews, the researcher obtained the informed consent of participants after explaining the purpose and process of the study. The researcher interviewed each participant one time, and the average interview duration was between one and a half to two hours. All interviews were recorded. In the case of teachers, following the in-depth interviews, the researcher then conducted participant observation in classes two times for 2 hours, for a total of 4 hours for each class. This was done to help clarify the contents of the interview. The researcher video- and audio-recorded these observations and took notes. She performed participant observation as an observer (Gold, 1958) and observed the class as a peripheral participant (Adler & Adler, 1998). She observed the teacher's way of teaching, student responses, how students learned, and what they learned. In addition, the researcher received and analyzed accessible documents such as the "Education Plan," "Educational Practice Plan," "A Study on the Establishment of Industry-School Collaboration System to foster a prestigious vocational school," and the school newsletter, among others.

Data analysis

The researchers analyzed the collected data through the following procedure. First, they transcribed the interviews and documented all of the participant observational content. They organized the data by comparing them with the notes written in the field and tried to secure the validity of the study by analyzing documents and various data related to the

school curriculum. Second, the researchers listed and classified the transcribed data of in-depth interviews, participant observations, and literature analysis. They categorized, classified, and analyzed the contents that were repeated many times or are common content among collected data into sub-areas. As noted above, one of the most important strategies to ensure validity in qualitative research is the procedure followed, such as ensuring diverse sources, describing carefully the collection of material, and identifying participants (Creswell, 2007).

Findings

Activity systems of Korean Meister high school

As a result of analyzing the activity systems of teachers and students in two Meister high schools through the framework of activity theory, this study reveals the primary object to the activity systems of both students and teachers: to develop skillful employability.

To achieve their object, students use classes, internship programs, practical training, and projects as tools. Also, with this same object, students and teachers work collaboratively as a community in the activity. The community performs tasks such as carrying out assignments, participating in classes and projects, and teaching and helping each other in order to achieve this object. The rules of the Meister high school nurture policy and of the Ministry of Education regulate students' actions insofar as they advance students toward their object.

The teachers' activity system indicates that they also are invested in the object of improving students' skillful employability. In their activities, teachers use their curriculum, textbooks, and supplementary teaching materials as tools. Peer teachers collectively work to develop the curriculum and teaching materials as a community. The rules of the Meister high school nurture policy and of the Ministry of Education influence how teachers act to achieve the object.

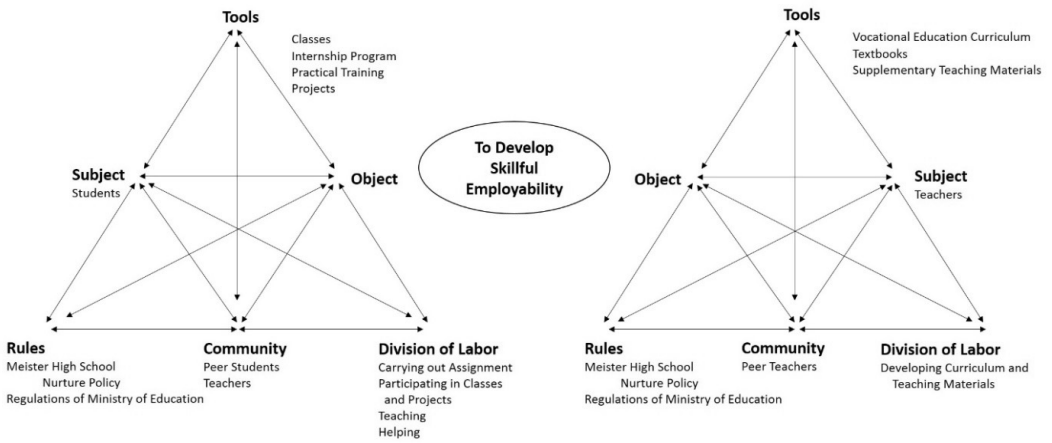

Figure 2. Activity systems of Meister high school education

Contradictions in Meister high school education activity systems

In the activities of both students and teachers, structural conflicts arise. In particular, contradictions occur between two components in activity systems.

Contradictions in students' activity system

For vocational education students to be successful in the labor market, it is necessary to match, as closely as possible, the functioning of that school with the corresponding work environment. To do this, the school must implement a curriculum that meets the needs of the field, and students should be able to experience and learn from these curriculums as they are. Despite each of these processes needing to be consistent, there have been inconsistencies between the education required by industry, the teaching that teachers provide, and the education that students experience.

Students improve their practical skills required by industries through a specialized curriculum. However, as they enter the actual workplace following graduation, they face difficulties due to a lack of understanding of basic business manners and skills.

> *I had a lot of opportunities to learn specialized knowledge. It was great… I had basic [specialized] knowledge, so I could work smoothly in the company… When I joined the company, the most difficult thing was relationships in the workplace. I wish I had more opportunities to learn about these really necessary skills in the company such as how to write an email or communicate with others from the school. (Woo)*

Meister high schools focus on improving the specialized skills required to perform jobs. In other words, the education given by Meister high schools is focused on providing practical skills that can be used in the field. This teaching method has structural deficiencies, making it difficult for students to possess professional skills and to develop the attitudes necessary for professional life and company culture. This reveals the contradiction between rules and object in the activity system.

Meister high schools have been trying to cultivate talents that meet industry needs. However, educators struggle to meet all of these needs through the schools' classes. Some school-run training programs are simply outdated; classes, projects, and practice activities based on the latest trends in the industry have difficulty keeping pace with the rapidly-changing realities of industry. Once they begin their new jobs, graduates still struggle to learn skills on site. In a student's activity system, this aspect appears to be an internal contradiction between the tool and the object.

> *The learning I got from three months or six months at work was more helpful than the learning I got from three years at school. I think this situation is unavoidable because it is impossible to learn techniques, before selecting a certain company from the first year at school...(interruption)... When we first went to work, the parts were different from those that we practiced soldering in our second year [of vocational school]. The things we practiced at school were all old products… No matter how much I practiced, it was different from what I would be doing in my company. That was confusing. (Han)*

> *After entering the company, I really felt that I was lacking a great deal. I even thought I had*

learned more in six months at work [than what I learned in vocational school]. I could not utilize immediately what I learned at school. In the company, I had to dig into it more intensively than I had learned at school. I hope the school is able to gather more information about what graduates must learn at the company. So by learning the skills that are used directly in the company, I hope that students will not be embarrassed when they get a job later. (Cha)

Government policy over-emphasizes the improvement of hard skills. Consequently, Meister high school education focuses heavily on providing students with technical abilities. It falls short of making students well-rounded skillful workers with both hard and soft skills. In this regard, Meister high school education experiences a contradiction between the rule and the object in the activity.

In addition, practical training programs in the schools are sometimes outdated. Although classes, projects, and practice training are based on recent trends in different fields of industry, the tools provided for the students are usually not cutting edge, unlike those which are actually used in the industry today. This leaves students ill-equipped to handle the tasks expected of them at their new job. In terms of students' activities, these aspects can be described as an inner contradiction between the tools and the object of students' activity.

Resolution of contradictions

The activities of students also entail contradictions. In reality, not only hard skills but also soft skills are necessary. However, the students described gaps between what they learned in the schools and what they were expected in the practice. When students encountered them, they reacted collectively to resolve them. This resolution took the form of after-school programs, in which students are able to acquire the special knowledge that the industry requires and develop competency with professional etiquette and skills not addressed in class. This is indicative of expansive learning taking place (Engeström, 2001): the improvement of Meister high school education by the main subjects acting within the activity system, the students and their teachers.

By actively participating in after-school classes, students gain practical knowledge and skills that they cannot acquire from their regular classes. In reality, experts or senior students involved in after-school classes share their field experience and practical know-how. Because after-school classes have more autonomy than regular classes, they play an essential role in resolving the contradiction occurring in the students' formal, school-day activities.

Students used the after-school classes to address the contradictions between the tools and rules of the activity system. After-school classes have emerged as a flexible mechanism that can reflect the voice of the students. This study confirms the possibility that learners can actively form meaning—that is, determine what they learn and how to learn on their own—by learning from the experience of peer learners who have completed or are currently undertaking an internship in a real workplace. Students were also able to acquire relatively specific knowledge according to industry requirements through after-school classes.

Teachers from outside of school come to the after-school classes… They talked about their office life and showed what they did in their company. It is closely related to the actual working practice. (Woo)

Personally, I received much more help from the after-school classes… If I had just taken regular classes when I found jobs, I would have just answered what others already know. However, I was able to answer better, because I participated in the after-school classes. I could explain what I actually did [in the after-school classes]. (Cha)

In the case of after-school classes, they were. Regular classes could not be changed arbitrarily, but after-school classes reflected a lot of students' opinions...(interruption)... When we do an internship or after we graduated, a lot of teachers asked, "What is the most necessary part of the company?" Sometimes, they also included in regular classes what we said, or the teachers in charge of each department referred to what we said, in designing a curriculum. (Yi)

The principal subject of learning is ultimately an individual who can build a meaningful purpose through activities at school and work. As Yi mentions, after-school classes that reflect and constitute the opinions of the students are a good example of a bottom-up pathway to effecting change in the school community.

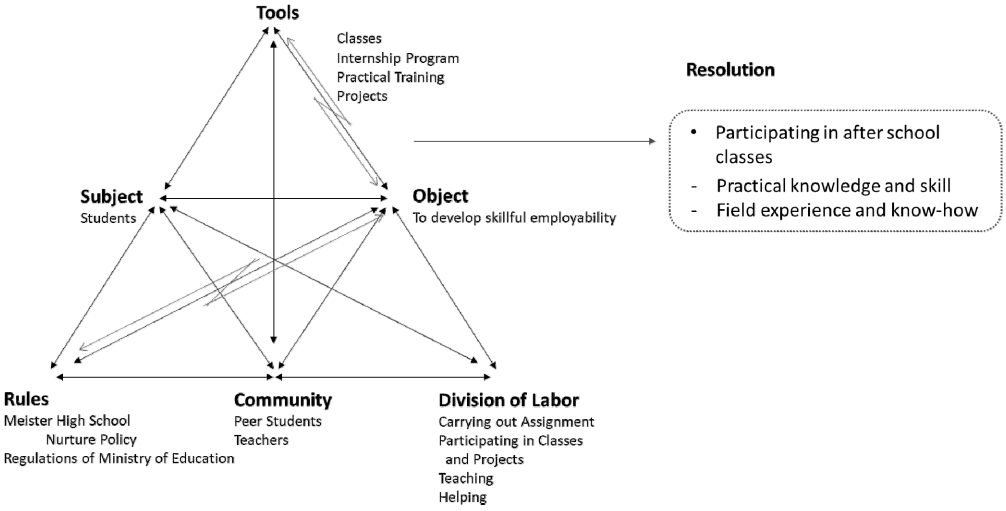

Figure 3. Contradictions and resolution of students' activity in Meister high school education

Contradictions in teachers' activity system

Although government policy gives teachers in Meister high schools the freedom to develop the curriculum they teach, they struggle to provide effective teaching materials because of a lack of proper textbooks in technical subjects. The present textbooks in technical subjects offer nothing in the way of specific or specialized content. Also, textbooks cannot keep pace with rapid evolution of the industries they seek to describe.

The textbook is the most difficult part. Subjects change a lot. For example, I have to teach Android and IOS next year. But it takes around three to five years to publish textbooks through the process of designing, writing, and editing the textbooks. So the textbook isn't suitable [to use]. Three years later, the textbook isn't necessary anymore. Also, we teach the things

demanded by industries, so we don't have the textbook itself. Teachers have to make it on their own. (Choi)
The hardest thing was [having] no textbooks. We studied by ourselves in person, or some textbooks used by college students. There was a textbook, but it was at a basic level, and producing a textbook specifically for a specific field was the biggest burden… On the contrary, Korean, English, and mathematics textbooks were overflowing... Such a part was difficult. (Park)

This addresses the structural contradiction between the tools and the object in teachers' activities in Meister high school education.

Resolution of contradictions

While contradictions address conflicts and obstacles, they create change and catalyze development through the process of resolving them (Engeström, 2008). The teachers of the Meister high schools faced two significant contradictions: the gap between industry practices and their classrooms, and the lack of textbooks to teach new fields. To resolve these contradictions, teachers autonomously develop informal textbooks and assemble their own supplementary teaching materials referencing other professional books or university textbooks.

Textbooks have limitations regarding the teaching of theories and recent professional knowledg e… For example, a program like LabVIEW is not covered in [a regular] high school curriculum, just in our school. Since there aren't enough textbooks and it is difficult to deal with projects or practical training with textbooks, I use university textbooks a lot and suggest projects with professional books. (Kim)

Teachers also learn for themselves, by participating frequently in training workshops and by undertaking various projects to develop curriculum and teaching materials.

We design the curriculum, so we need to find the demands of practical fields. I always pay attention to trends, issues, conferences, and training workshops… I often meet people in practical fields… The best way is to do projects. When doing a project, I have to make something that is practical… I read books or search on the Internet. It is learning itself. (Park)

Conclusion and implications

Drawing on activity theory, this study has analyzed the activity systems of teachers and students through a qualitative case study of an electronics and a media Meister high school, a representative secondary vocational education institution in Korea. The researchers critically approached the curriculum at each Meister high schools and examined their implementation based on the contradictions revealed in the activity system. They analyzed the schools' curricula by focusing on the extended learning that emerged during the process of resolving these contradictions. Based on the results, the researchers have reached the following conclusions.

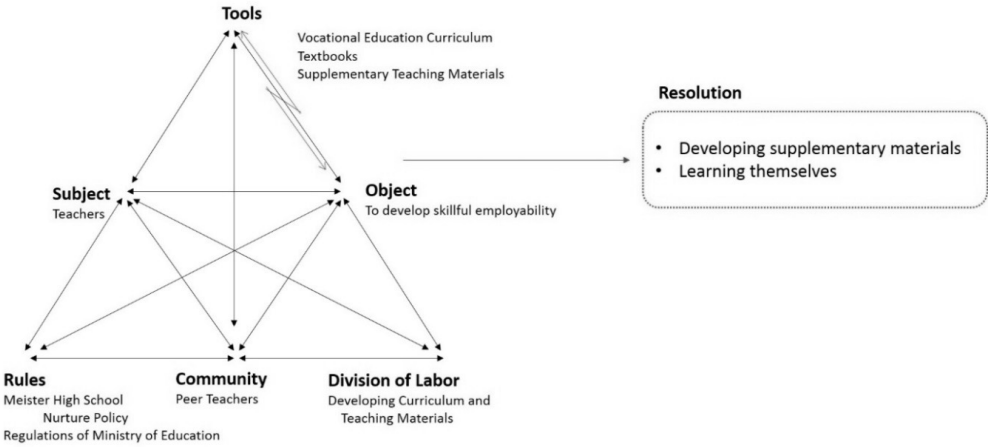

Figure 4. Contradictions and resolution of teachers' activity in Meister high school education

The Meister high schools were operated in a typical top-down way. In other words, it endeavored to train a customized workforce that would meet the needs of the economy and industry based on government-defined objectives. The Meister high schools in this study claimed to be models of an industry-tailored school. They strived to achieve a smooth school-to-work transition by narrowing the gap between the technology required by the industry and the technology learned in the school. However, despite trying to incorporate and align to industry needs, the curriculum contained educational structures and content that did not coincide. The results of this research show that Meister high school education was effective at improving the practical skills for job performance through customized education that responded to industry needs. This type of education, however, is limited in being able to cultivate well-balanced technologists; in particular, it fell short of properly nurturing attitudes and communication skills as well as technical skills. Meister high schools were aligned with the plan to cultivate tailored technicians with skills required by industry. They were not, however, aligned with plans to train a well-rounded technologist. This became evident through the research with students. The students' experiences at the workplace diverged significantly from their experiences in the school. Nevertheless, students tried to resolve this contradiction by actively making use of after-school programs. In the after-school classes, which are driven by students' interests and opinions, the learners were able to develop special knowledge that they could not learn in class, and they found that they could act as meaning-makers.

The administrators at Meister high schools had to try to make their curriculum keep pace with the rapid changes and needs of industry. In this process, structural contradictions occurred due to the fixed, planned curriculum and government-set regulations. An examination of the activity systems of teachers and students—the subjects of actual education—shows significant limitations in keeping up with the rapidly changing needs of the industry. This was mainly due to the fixed and planned curriculum and regulations, which thwarted the formation of a more dynamic relationship between the school and its corresponding industrial field. Despite these structural contradictions, teachers augment and redesign the top-down curriculum through informal mechanisms, such as making their own textbooks and incorporating a variety of external material into their teaching. In addition,

they learn through various training and self-study how to incorporate rapidly changing industry skills and trends into their curriculum. In other words, teachers have transformed various tools for education that are more specific and specialized than what is offered by the existing framework—the planned and intended curriculum set by government policy. The teachers developed these tools to reflect the voices of students who had industrial experience through the after-school program. As a result, teachers and learners were observed to be developing themselves as the main subjects of Meister education, actively trying to overcome its inherent contradictions. This shows that vocational education not only helps subjects acquire simple knowledge or skills, but also to improve the possibility of being an active learner.

These results show that Meister high schools are operated with the limitations and problems generally associated with a top-down vocational education. The Korean government sought to directly unite education with employment by implementing vocational education that suits the needs of the industry through the secondary vocational education policy (Meister high school policy). In fact, as of April 1, 2013, the employment rate of the graduates of Meister high school was 90.3%. However, to increase the educational effect of Meister high school in the long term and in a practical way, learners need to be considered as the active meaning-makers from a constructivist perspective in a bottom-up pathway. This is to say, to design an effective vocational education curriculum, not only economic and industrial needs, but also learners' needs, should be considered. The curriculum should also focus on developing the capability of learners, rather than focusing only on the uptake of learning outcomes, by allowing students to enhance their learning experience through their own initiatives. In addition, approaches should be expanded, based on the workplace, context, and situational centered perspectives. The core vocational curriculum, which is the product of top-down design processes, is limited in that it does not reflect the actual educational needs of its subjects (the students and teachers). Going forward, it is clear that, for this type of education to be successful, it is necessary for the curriculum and overall learning environment to be approached from the view of the subjective learner, actively invested and involved in shaping their own education.

As previous vocational high schools failed to respond flexibly to the demands of industry and the number of unemployed high school graduates increased, the government tried to reform various regulations in education by operating industry-tailored schools. The vocational curriculum of the Meister high school reflected and applied the demands of the industry to help students transition to the workplace. With the Meister high school policy, the government hopes to promote secondary vocational education by narrowing the gap between the industrial field and the school curriculum, making a smooth transition to the workplace after graduation. The most important action was to fully liberalize the textbooks, to implement industry-customized education. Nonetheless, some aspects of the industrial environment could not be squared with that of the schools, because the situation or context was too different. It is even more difficult to narrow the gap between schools and industries through a curriculum that is focused too heavily on basic technical skills and not at all on the development of soft and professional skills.

Since vocational education is still in a system in which schools and workplaces are separate, it is difficult for schools to keep up with the rapidly changing needs of industry. However, to facilitate the school-to-work transition, policymakers are discussing how to make close connections between schools and the workplace (Akkerman & Bakker, 2012). The government's efforts are overwhelmingly aimed at resolving social problems, such as

the stagnation of the employment rate, the lack of good jobs, and high youth unemployment by linking schools more closely to the workplace. Vocational education has generally developed in close ties with these socio-economic concerns, and its development has been driven by national interests.

With the advent of a new industrial economy, the vocational education system has been influenced by the effective supply and management of skilled workers, the employability of young people, and the achievement of national and civic goals (Billett, 2011). Vocational education has been discussed in terms of social needs, rather than with a focus on individual needs. Various systems related to education and work have not escaped the existing concept of vocational education, since the subject of educational needs is framed in "national" and "industrial" terms (Billett, 2011). Although the government has tried to initiate a dynamic vocational education system, its policymakers have failed to include in their discussions of the system's design the actual learners who are the subjects of that education. The subject of learning is the individual, and individuals organize their meaning through activities in school and the workplace.

Therefore, in vocational education, it is necessary to move away from the narrow concept of supply and demand in terms of national and industrial needs. Vocational education should be discussed from various and broad perspectives that are centered on learners, the actual subjects of learning (Na & Kim, 2008). From the viewpoint of a national vocational education system, the efforts so far have been made to make the systems of school and workplace the same, in order to closely link work and education. In recent years, however, in northern Europe, there has been an increasing number of socio-cultural studies acknowledging that schools and industries are socio-culturally different systems, and learning takes place through these differences (Guile & Griffiths, 2001; Tuomi-Gröhn, Engeström, & Young, 2003). Awareness of this insight will help vocational education meet the qualifications and expertise required by contemporary society and industry, and to nurture multifunctional, well-rounded workers and creative talents who nevertheless possess the specialized knowledge of their chosen field. Above all, in any approach to vocational education, it is necessary to go beyond the top-down approach that focuses only on national and industry demands. It is necessary to reframe a underpinning philosophy of these schools, from a mere pathways between school and the workplace, students and workers, to seeing them as educational environments focused on learners, who are interested in taking an active part in shaping their education.

Therefore, to enter the labor market only with a secondary education course, it is necessary to take a more active, bottom-up approach to vocational education. To cultivate well-rounded technologists, it is necessary to emphasize the expansion of the operation and participation of project-based classes, the expansion of the autonomy of schools in the design and operation of curricula and textbooks, and the fundamental improvement of curriculum organization directives that reflect changes in industry needs and student skills. In this study, the researchers have observed efforts already in place to implement these needed changes, such as the informal after-school classes, which are driven by students' interests and experiences and ultimately feedback into the development of more suitable and effective formal classroom curriculum. This enables an exploration of the possibilities of a constructivist, learner-centered vocational curriculum. In the future, we hope a new perspective to take hold which makes it possible to improve the vocational education curriculum through bottom-up initiatives, allowing a closer linkage between school and the workplace.

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Primary schools' initiatives and challenges in cultivating sustainable reading habits among pupils in Tanzania

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Abstract

This study investigated primary schools' initiatives and challenges in fostering pupils' reading habits in Tanzania against the backdrop of general apathy toward poor reading habits particularly in public schools. Three questions guided the study: What does a reading habit mean to teachers, pupils and parents in primary education? How do primary schools promote reading habits among pupils? What challenges do primary schools face in cultivating reading habits among pupils? Data was collected through interviews, documentary review, and observations. The sample comprised teachers, pupils, and parents. The findings show that in general teachers, parents and pupils understood the concept of a reading habit. Moreover, having school book stores, encouraging pupils to buy books, administering activities that urged pupils to read books, and encouraging pupil reading were initiatives primary schools employed to cultivate pupils' reading habit. The study identified pupils' low interest in reading books, lack of books, absence of school libraries, pupils' semi-illiteracy and the high cost of books as challenges that schools had to contend with in promoting pupils' reading habit. The study concludes that the onus was on all primary education stakeholders to shoulder the obligation of initiating and cultivating pupils' reading habits.

Keywords: initiatives and challenges, primary school pupils, reading habits, qualitative research, Tanzania

Introduction

The motivation to research the reading habit among school pupils in Tanzania first emerged on 9 February 2005 at the Heathrow Airport in the United Kingdom. Returning to Scotland from a six-month fieldwork for my PhD project in Tanzania, I changed flights at Heathrow. While awaiting my flight to Scotland in the departure lounge, I noticed something that almost all other transit passengers awaiting connecting flights to Bristol, Edinburgh, Glasgow, Manchester, Newcastle, Leeds, Belfast and other destinations had in common—a reading culture. To my dismay, with the exception of myself, virtually every transit passenger was engaged in reading either a book or a newspaper. The reading would cease immediately one heard on the public announcement that one's flight was ready and the reader would in haste gather his or her belongings in readiness for departure.

The habit or rather love for books, I believe, is firmly anchored in one's cultural environments such as the home (family), school, and street (peer group). As Nyerere (1968, p. 108) aptly states, "It is a fact which we must recognise, that in dealing with the modern world children in Europe have two big advantages over our own children. One is the familiarity with mechanical things; the other, and perhaps even more important one, is familiarity with books." Amongst others, as highlighted elsewhere, the family, school, community, and streets are agencies that underlie the socialisation process. Each of them plays a pivotal role in orientating children to embrace the habit of reading (Clark & Foster, 2005; Nalusiba, 2010; Yusof, 2010) and eventually cultivate a sustainable reading culture.

Whilst the reading habit appears to be a fait accompli in virtually all developed countries, the developing world context, especially Africa, tells a different story. In this regard, extant literature attests to the low stature of the reading habit in many African countries (Magara & Batambuze, 2009; Mahala, 2010; Mulindwa, 2001; Owusu-Acheaw & Larson, 2014; Ruterana, 2014). Like elsewhere, in Africa, reading is a social-cum-academic practice for fostering literacy. Various explanations can account for this low urge to read books in Africa; nevertheless, a reading habit and ultimately a reading largely require cultivation and nurturing. Usually, the process of cultivating a reading culture begins early in childhood at home or at school (Busayo, 2011; Chettri & Rout, 2013; Kachala, 2007; Mahala, 2010; Majid & Tan, 2007; Tella & Akande, 2007). At home, parents and/or guardians have the obligation of providing reading opportunities to their children. This trend is arguably evident in many Western societies at the familial level although less so in low Socio Economic Status (SES) areas. In the African milieu, however, this practice only occasionally features in a few households that have educated parents and/or guardians (Yusof, 2010). So often, in many African countries, it is usually children from educated parents who are likely to enjoy this privilege. As one African researcher puts it, "the findings reveal that the attitudes of parents affected children's reading and that children from homes where parents are literate were more likely to enjoy reading and to be encouraged to read than in homes where parents were illiterate" (Mulindwa, 2001, p. 2). Indeed, a supportive environment coupled with resource availability can be a game-changer across many communities.

Besides parents at home, teachers and/or the school environment play an instrumental role in laying the foundation for the development of pupils' reading habit (Camp, 2007). Such a role takes on board the fact that schools are settings that grant children, irrespective of their cultural, economic, and social backgrounds, a forum for developing and nurturing

different skills or attitudes inter alia the reading habit (Bwayo, 2014).

Based on the Tanzanian experience, this study attempted to determine what primary schools do to assist school children to develop reading habit. Amongst others, school libraries provide pupils with an opportunity to develop the habit of reading. In principle, schools are expected to have libraries and arrange for pupils to visit libraries on regular basis. Well-furnished school libraries, for example, serve as venues for pupils to cultivate and develop a habit of ardently reading books: "Giving someone the reading habit, on the other hand, involves providing a continuous supply of easily processed fuel so that the new driver can go places, can get to enjoy driving and can eventually realise the limitless possibilities it opens up" (Philip, n.d., p. 1).

Certainly, the world's primary schools in general and Tanzania's in particular normally shoulder the responsibility of inculcating a reading habit among school children (Applegate & Applegate, 2004; Clark & Foster, 2005; Majid & Tan, 2007; Wanjari & Mahakulkar, 2011). Primary education provides basic learning to all school-age children in the country, most significantly foundational reading skills. Post-primary education programmes build on the educational foundations laid by primary schools. However, the literature available on Tanzania appears to suggest that these foundations for developing a reading habit are generally shaky (Nyerere, 1968). Similarly, Mwageni (2017) and Wema (2018) indicate that the reading habit among Tanzanian students, even in institutions of higher learning, is rather low when the opposite should be the case. This paper investigates the initiatives and challenges inherent in efforts to develop a sustainable reading habit and, ultimately, culture in Tanzania's primary schools, hence sowing a seed for cultivating a life-long reading habit.

Purpose and research questions

This study investigated primary schools' initiatives and challenges in cultivating the habit of formal and informal reading materials among pupils in Tanzania. Reading materials relevant to syllabi of various academic disciplines formed part of formal reading materials, including reference and text books. Informal reading materials, on the other hand, include newspapers and other literary materials that pupils read or can read for leisure. The study was premised on the assertion that primary schools, as important agencies in the pupils' socialisation process, have the responsibility for helping them develop a habit for reading books (Kaungamno & Ilomo, 1989). To accomplish the purpose of the study, three research questions guided the study:

a. What does a reading habit mean to stakeholders (teachers, pupils and parents) in primary education in the selected research sites (i.e. Iringa and Mbeya regions)?
b. How do primary schools promote reading habits among school pupils?
c. What challenges do primary schools face?

Significance of the study

This study attempts to promote a firmer understanding of the intricacies of promoting reading as a habit in the developing world, limited resource context of Tanzania's primary schools. To begin with, the research findings can inform the decisions of various

stakeholders on the best approach to promoting reading as a habit among pupils. For education policy-makers, school quality assurance officers, teachers as well as parents and/or guardians, this study provides an opportunity for them to rethink sustainable ways for mitigating challenges that frustrate initiatives geared towards fostering school pupils' reading habit. Second, the research findings seek to initiate dialogue among scholars on the reading habit among students in other institutions of learning, including secondary schools and universities. Third, the research findings obligate stakeholders to gravitate creating an environment amenable to cultivating a reading habit in schools. Fourth, the research findings serve as an eye-opener to researchers who would like to undertake research projects on learners' reading habit in the developing, resource-poor context generally and Tanzania in particular.

Limitations of the study

Like other research projects, this study had several different limitations. First, as is the case with qualitative inquiries, the number of participants involved in this study was small. Thus, findings are not generalizable to other parts of the East African region. Second, the availability of literature on reading habits particularly in the localized context of Africa and Tanzania more specifically was limited. Indeed, there were no empirical studies from an exclusively Tanzanian perspective. As a result, the focus was on research reports drawn from the experience of other countries which did not necessarily share socio-economic and cultural experiences with the research sites for the present study. Third, unwillingness of some prospective informants due to other prior equally pressing commitments to their professional obligations impacted the process of data generation. Consequently, I had to opt for informant teachers who were available for the study. Fourth, given their age, access to children's experience of reading habit was problematic. It was, thus, deemed necessary to engage parents and teachers. Unfortunately, some of them were so bureaucratic that the process of data generation was not implemented as scheduled as there were some delays.

Review of literature

In the review of related literature, first, the focus is on the conceptual and theoretical overview of reading habits. Second, the review indicates that the concern over reading habits is historical in character. Third, the concern over the reading habit globally is briefly reviewed. Fourth, the importance of reading habit is delineated. Fifth, this section revisits the rationale for the current inquiry and establishes the knowledge gap that the study sought to fill.

The terms 'habit' and 'culture' have different meanings (Hornby, 2000). To begin with, the term "'habit' refers to 'a thing that you do often and almost without thinking, especially sth [sic] that is hard to stop doing' or 'usual behaviour'" (p. 530). The term 'culture', on the other hand, appears to suggest a 'way of life' (p. 284). In light of these meanings, three observations are made. First, human beings are conditionable to developing certain habits or ways of life. Second, the habit or culture is, indeed, an integral part of one's day-to-day life in pursuing a certain course of actions. Third, the development of habit or culture is

attributable to either intrinsic or extrinsic explanations (Applegate & Applegate, 2004; Ryan & Deci, 2000). However, the question is: What does a reading habit or culture entail? The literature available defines 'reading habit or culture' as the behaviour that expresses the regular likeness of reading books (Chettri & Rout, 2013; Sangkaeo, 1999; Tella & Akande, 2007). Writing from the Tanzanian context, Mwageni (2017) synthesises the concept of reading habit as "patterns of reading attitude and behaviours which guide students to acquire knowledge, skills and experiences for academic purposes and lifelong learning" (p. 10). Usually, according to Camp (2007), "the habit of reading, like other habits, develops over a period of time" (p. 252). Arguably, it is a social undertaking or practice that needs to be nurtured and promoted. Nevertheless, in Tanzania, especially in rural areas and in some urban families perhaps due to social, cultural, and historical orientation, a person who sets aside time to read books seems lazy. As Nyerere (1968) puts it, "Too often in our own society a person who sits down to read is accused of being lazy or of being unsociable" (p. 108).

Generally, literature acknowledges a worldwide concern over particularly the lack of culture of reading books, which has a long-standing history (Hoar, 1960; Nwikina, 1953). In Nigeria, for example, as in many other African countries, according to Nwikina, the reading habit concern dates back to the colonial era. However, given the character and nature of colonialism, the number of Nigerians who had access to books was initially negligible as a result of the fact that during the colonial era a few Africans had access to schools. Certainly, the colonial character appears to apply to all colonies. Presently, in Tanzania and, more widely, elsewhere in Africa scholars still raise their concern about the lack of reading habits. The implication is that even in the post-colonial period the problem of reading habit still remains. According to Nyerere (1968), a person who showed interest in reading was accused of being lazy or unsociable. To that effect, the question worthy of pursuit is related to why scholars continue to raise concern over the habit of reading. Consider the following excerpt on the importance of such a habit: [...] "The importance of reading cannot be overemphasized and this is because reading plays a very crucial role in enabling a person to achieve practical efficiency" (Tella & Akande, 2007, p. 118).

There is ample empirical evidence underscoring the benefits accruing from reading books (Otike, 2011; Tella & Akande, 2007). Indisputably, the reading habit helps people to grow mentally and fulfil their full potential. The advantage a reading habit engenders is vital irrespective of one's educational and social background. Indeed, the reading habit shapes and informs the thinking of readers: It may promote students' critical thinking and helps them to confirm or challenge older versions of knowledge (Mosha, 2006). In particular, this concerns students at all levels of education (Mlay, Sabi, Tsuma, & Langmia, 2015). However, this does not exclude people outside the formal school or education system: "Neither a subsistence farmer nor a graduate chemist can fulfil his or her potential without the cognitive growth that comes from reading widely and people will not read further than their immediate needs if they are not given the reading habit" (Phillip, n.d., p. 9). Similarly, studies by Akanda, Hoq and Hasan (2013), Mahala (2000), and Mulindwa (2001) appear to stress that countries or people in different parts of the world improve their socio-economic well-being as a result of getting access to relevant or better information. Such information is usually attained in several different fields or areas of specialisations such as education, medicine, law and ministry. There is little doubt that reading books and other literary works contributes to development (Nyerere, 1968).

Based on the contribution of the reading habit to the realisation of the readers' or

people's full potential, libraries play a vital role in this respect. Libraries provide readers with a forum for improving and reinforcing their reading habits. The review of related literature reaffirms the indisputable role libraries play in schools or education settings: "The use of school libraries is the foundation for the use of all other libraries. Literacy is nurtured in schools and is the prerequisite for all subsequent library and information use" (Kaungamno & Ilomo, 1989, p. 283). Without reading, literacy faces a dead-end for lack of a supportive and enabling boon. Pupils, whose background does not provide them with a foothold for cultivating a reading habit, may find the school or city or public libraries remain the few possible means to do so. And yet, in many African countries the problem of lack of library services is endemic (Magara & Batambuze, 2009). Nevertheless, there is no evidence of the relationship between the availability of libraries and people's reading habit in Africa. As such, reading sensitisation forums and establishment of libraries in rural and semi-urban areas are required. This observation is pertinent because, as Tella and Akande (2007) indicate, there is "stigma already associated with Africa as a continent with a 'Poor Reading Culture'" (p. 1). More significantly, it should be noted that the optimum time to develop the reading habit is in childhood:

> All of us know from our experience that reading, which begins in childhood, enables a child to develop love for books... Therefore, to be able to cultivate a culture for reading at national level we have to begin with children (Original version in Kiswahili: 'Sisi sote tunajua kutokana na uzoefu wetu kuwa, kusoma kuanzia utotoni ndiko kunakomwezesha mtoto kujenga mapenzi ya vitabu... Kwa hiyo, ili tuweze kujenga utamaduni wa kusoma kitaifa hatuna budi kuanza na watoto wadogo') (Mwansoko, 2008, p. 2).

Many of the studies carried out in Tanzania appear silent on ways of fostering the pupil's love for books and other literary works and the contribution of schools in this endeavour. Neither do they exclusively delineate the challenges that schools encounter in cultivating a book reading habit among pupils. This study, therefore, aims to stimulate a dialogue on pupils' reading habit promotion so as to address the prevailing knowledge gap. Moreover, the findings of this enquiry can help schools and parents devise means for further promoting children's positive attitude towards reading.

Methods

Research sites

The study was carried out in Tanzania, East Africa. In particular, the study drew on data generated in four districts—Iringa Municipality, Iringa rural (Iringa), Rungwe and Mbeya urban (Mbeya) of Tanzania. The four districts involved in the study have more or less similar characteristics in which all government-owned and funded primary schools operate. These districts were purposively chosen for the study. In total, they had 438 primary schools. However, in each district, the focus was on two government-run primary schools as these schools are not only the staple of the country through which universal primary education is offered but also are places where children from different

socio-economic backgrounds could cultivate the habit of reading without being inhibited by the exorbitant cost of education applicable in private primary schools. Education provision in Tanzania is attained through both private and public sectors, with the latter carrying the heaviest burden.

Research participants

Three categories of informants participated actively in the study: teachers, pupils, and parents. These three categories of participants were recruited for the study because they were key actors in the pupils' learning processes (Emerson, Fear, Fox, & Sander, 2012; Maluleke, 2014). Teachers, for example, deal with day-to-day pupils' academic activities, including reading books. As Magara and Batambuze (2009) put it, teachers play a pivotal role in fostering a reading culture in schools. Thirty-two primary school teachers whose age ranged from 25 to 52 years were purposively selected for the study. Of these, 13 were female teachers. As these teachers had experience of teaching in primary schools, they were considered necessary for the study. As for parents, they are responsible for the development of their children's reading habit at home. Indeed, under normal circumstances, homes or parents are the first socialising agents (Haralambos & Holborn, 1990; Walsh, 1994). Sixteen parents were also purposively selected for participation in the study. Of these, there were six female informants. The age of the parents involved in the study ranged from 42 to 61 years. The parents' involvement in the study was deemed necessary because they had children in primary schools.

As for pupils, their inclusion in the study was based on the assumption that understanding the pupils' reading habit also entailed listening to their voices to get first-hand information on their lived experiences. Specifically, pupil informants chosen to participate in this study were fourth, fifth, sixth and seventh graders. The "stratified purposive" technique, as advocated by Creswell and Poth (2018, p. 159), was deemed necessary in selecting pupil informants for this research project. The ages of school pupils in these grades range from 10 to 14, under the Education and Training Policy of 1995 (United Republic of Tanzania [URT], 1995). In all, sixty-four pupil informants were involved in the study, including thirty-five female pupils. Although generalisation of results in qualitative research is arguable (see, for example, Payne & Williams, 2005), there is justification for the generalisation of this research to other parts of Tanzania sharing similar characteristics. Primary schools in Tanzania operate in a more or less similar environment as they are largely funded and owned by the government.

Data generation and analysis tools

A combination of data generation methods informed this study. First, interviews were conducted with teachers, parents, and school pupils on school initiative in and challenges to cultivating pupils' reading habits. Second, document review (Akanda, Hoq, & Hasan, 2013; Busayo, 2011; Camp, 2007; Chettri & Rout, 2013) entailed a critical scrutiny of materials—both print and electronic—on children's reading habits. Third, observational review allowed the researcher to determine whether or not schools involved in the enquiry had libraries in their premises. The study's data analysis drew on the qualitative research

approach (Creswell & Poth, 2018; Huberman & Miles, 1994; Sarantakos, 2005). Specifically, the analysis of data was guided by Huberman and Miles' (1994) three-stages of qualitative data analysis: (i) data reduction, (ii) data organisation, (iii) and data interpretation.

The data analysis was an ongoing process, which also facilitated validation. The researcher undertook the analysis several times to get a sense of the data from interviews, document review, and observations (Creswell & Poth, 2018). Moreover, as Mills and Gay (2016) suggest, the process of data analysis was attained through a multi-instrument approach to data analysis which took on board the use of multiple methods, data generation strategies, and data sources (p. 397). In this respect, the multi-instrument approach or triangulation helped to validate the results. Finally, data analysis was conducted in accordance with the research questions of the study.

Data collection and data analysis were carried out between 2010 and 2014. As Creswell and Poth (2018, p. 185) confirm, "[T]he processes of data collection, data analysis, and report writing are not distinct steps in the process—they are interrelated and often go on simultaneously in a research project." The two processes were executed simultaneously. Table 1 presents a summary of the research schedule for data collection and analysis:

Table 1. Research schedule for data collection and analysis

Activities	Data	Data collection and analysis framework	Time
Data collection	Qualitative data	Interviews, documents, and field observations	Data collection and data analysis were executed simultaneously between 2010–2014
Data analysis		Huberman and Miles' (1994) framework of data analysis: Data reduction, organisation, and interpretation	

Ethical statement

The study followed all ethical research protocols (Creswell & Poth, 2018; Mills & Gay, 2016). To begin with, research approval was obtained from district education offices, which in turn issued introductory letters for onwards submission to participating to schools. Moreover, every individual informant—teacher, parent and pupil—provided informed consent after being briefed on the nature of the study, as advised by Creswell and Poth (2018). Furthermore, the informants received assurance that the study was for educational purposes and participation was voluntary. The information from interviews, documents and observation was treated with confidentiality, with the identity of informants remaining anonymous (Sarantakos, 2005). Finally, all the authors whose works or ideas informed this study have been duly acknowledged.

Findings

The research findings respond to three major three questions: (i) What does reading habit mean to stakeholders in primary education; (ii) How do primary schools promote reading habits among pupils; and (iii) What challenges do primary schools experience in promoting a book reading habit?

What does reading habit mean to stakeholders in primary education?

The first question on defining and describing the reading habit sought to establish whether people understand the crucial role of reading. The importance of reading is historically and widely appreciated (Chazal, 2003; Dutta, 2008; Gioia, 2006; Mahala, 2010; Nyerere, 1968). Reading contributes significantly to readers' enlightenment, development and the sustainability of literacy (Mwageni, 2017; URT, 1995). Thus through interviews, teachers, pupils, and parents were asked to share experiences on what they understand by the reading habit concept.

Reading habit defined: How do teachers, pupils and parents understand the concept of reading?

Each of the categories of stakeholders involved in the study understood the concept of reading habit in different ways. Research findings on the indicators of teachers, pupils, and parents' understanding of the concept are summarised in Table 2:

Information in Table 2 suggests varied conceptualisations of the reading habit among the respondents. Teachers, parents and pupils do not understand the concept in exactly the same way. Yet, there were cases of informants, especially parents (peasants, school teachers, cooks, small scale business men and women) and pupils who admitted not knowing what the concept entails. They admitted to having had no idea whatsoever about the concept. As one parent informant indicated: "... honestly, I don't know what it means..." (Male parent, Iringa rural). As already indicated, pupils had mixed experiences about the concept. Yet, there were pupils who just kept quiet when asked to describe what constitutes a reading habit.

Table 2. Stakeholders' understanding of the concept of reading habit

Teachers' views

a. "...the desire to love reading books and other publications..." (Female teacher, Iringa Urban)
b. "...means to increase knowledge..." (Male teacher, Iringa rural)
c. "... a way to get knowledge from books, journals and newspapers..." (Female teacher, Mbeya urban)
d. "...act of pupils to read different publications, aiming at learning and entertainment..." (Female teacher, Rungwe district)

Parents' views

a. "...the state of loving to read books..." (Male parent, Rungwe district)
b. "…behaviour of reading books…." (Female parent, Mbeya urban)
c. "...increase knowledge and revise what one has been taught..." (Female parent, Iringa Urban)
d. "… a schoolboy to read what the teacher taught him … while at home…" (Female parent , Iringa rural)

Pupils' views

a. "...a means to increase knowledge beyond what teachers taught..." (Female pupil, Mbeya urban)
b. "...to get knowledge from books..." (Female pupil, Iringa rural)
c. "...the state of loving to read books..." (Male pupil, Rungwe district)
d. "…one's tendency to read books…" (Female pupil, Iringa rural)

Characterising pupils' reading habit: What do teachers and parents say?

To ascertain the understanding of the concept of reading habit, teachers and parents were asked to characterise pupils' reading habit. They provided the following characteristics based on the school and home environments as Table 3 indicates:

Table 3. Participants' characterisation of pupils' reading habit

Teachers' views
a. "...loving to borrow books and different journals..." (Female teacher, Iringa urban)
b. "...raising questions from books that she or he has read..." (Female teacher, Mbeya urban)
c. "...pupils' ability to respond to questions beyond what they have been taught..." (Male teacher, Iringa rural)
d. "...pupils' ability to provide correct responses from books that they have read..." (Male teacher, Rungwe district)
Parents' views
a. "...if you see a child holding books and newspapers regularly..." (Female parent, Mbeya urban)
b. "…when upon returning from school a child reads books; and he does not wander..." (Male parent, Iringa urban)
c. "…finishing household chores early so that to have long time for private studies..." (Female parent informant, Iringa urban)
d. "…upon return from school a child undertaking private studies and home assignments..." (male parent, Rungwe district)
e. "…when a child makes revision of what she or he has learned at school..." (Male parent, Rungwe district)

Information in Table 3 attests to the varied characteristics of pupils' reading habit proffered by teachers and parents. Even teachers though learned did not seem to have a firm or common grasp of these characteristics. Arguably, teachers' and parents' failure to define and characterise reading habit in the same way can pose a challenge to the effective promotion of pupils' reading habit in primary schools as they, no doubt would not be operating on the same page.

How do primary schools promote reading habits among pupils?

The second question on how schools promoted reading habits among pupils resulted in teachers, parents and pupils providing varied responses clustered under teachers' and parents'/guardians' approaches to fostering pupils' reading habits.

Teachers' approaches to pupils' reading habit

To begin with, teachers mentioned varied approaches or strategies their schools deployed to orientate pupils to reading books and cultivate their love for reading. In particular, they mentioned establishment of book stores, encouraging pupils to buy books, administering activities that oblige pupils to read books, and encouraging pupils to read books.

Establishment of book stores The study found that all the primary schools in the research sites had book stores. Unlike a conventional book store that sells books, these stores are storage rooms for books. Neither do they qualify to be called mini-libraries. They are stocked with books schools received from diverse sources, including the government. According to teacher informants, they were under the custodianship of a teacher who lent books out to the pupils, who wanted to read for leisure or assignments. As one teacher informant put it, "Teachers encourage pupils to read books. We encourage pupils to borrow books from the book stores" (Male teacher, Mbeya urban). However, having book stores as an approach on its own was found wanting as a strategy for promoting the pupils' reading habit. Usually, only a few pupils had enough courage to make requests of teachers and, thus, benefit from the school book stores. The majority of pupils, on the other hand, did not borrow from the book stores at all. In fact, none of the schools in the research sites was found to have guidelines in place to encourage pupils to borrow books kept in stores during the fieldwork. It was also established that some pupils were not even aware of the existence of school book stores. As a result, one book was last borrowed in October 1971 and by 2011 it had not been borrowed again.

Encouraging pupils to buy books Research findings indicate that teachers encouraged pupils to buy relevant books. This approach was deemed necessary as most of the primary schools did not have adequate books. According to the teachers, parents could buy books for school children from book shops and from book vendors in the streets. Encouraging pupils to buy books was meant to offset the lack of or inadequacy of books in schools. However, there were challenges to the approach. As one participant put it, "There are many challenges…without teachers' supervision pupils cannot read … There is a shortage of reference and textbooks; and lack of pupils' motivation…" (Female Teacher, Iringa rural). Moreover, this approach was reported as not feasible for all primary school pupils, particularly in those with very poor and illiterate parents who did not understand the value of books or simply could not afford them. As a result, the approach worked for pupils whose parents had a considerable level of formal education coupled with a stable and sizeable income.

Administering activities that obliged pupils to read books Teachers also reported involving pupils in activities that encouraged them to read books. The activities administered served as motivation for pupils to read books. In this regard, one participant said: "… we provide pupils with some books that are relevant to subjects they study in school so that they take them home…" (Female teacher, Iringa rural). Yet, the home environments for many households were not conducive enough to encourage pupils to read books. In rural areas and some families in urban centres, children did not even have study rooms. Some lacked lighting at night as they neither had electricity nor could they afford kerosene for lighting purposes on a regular basis. In addition, when many of the children returned home they spent most of their evening time attending to house chores. Based on experience in Malawi, Munthali (2004) and Sankhulani (2007) established that the situation was even worse for girls. So often, house chores interfered with girls' reading or learning schedules. In particular, Sankhulani (2007) asserts: "Most girls were also engaged in household activities after school and had no time to read or do assignments" (p. 102).

Encouraging pupils to read books During interviews held with teachers, it was established that they encouraged their pupils to read books using different techniques. As one teacher participant explained:

> It is for teachers who teach the language subjects to encourage pupils to read reference and textbooks. Also…to give them time to undertake projects in groups; and to administer adequate numbers of exercises…to administer weekly or monthly quizzes (Male teacher, Iringa rural).

This teacher insisted that this approach was relevant for both the teachers and pupils in language subjects. Traditionally, language subjects in Tanzania are Kiswahili and English. In recent years, French has also been added. Implicitly, some teachers in primary schools largely associated reading books with language subjects. Teachers for other subjects such as mathematics, social sciences, and science appear to overlook encouraging pupils to read books.

Parents and/or guardians' approaches to pupils' reading habit

Parents and/or guardians were also asked to indicate the approaches that they personally used to encourage school children to cultivate the habit of reading books. They reported using various ways outlined as follows:

Buying books for children to read The parents and/or guardians acknowledged being aware of their responsibility for procuring children's school or education requirements. Unlike in the past, today's parents share the cost of educating their children. This obligation largely draws on the Education and Training Policy of 1995 that spells out the place of stakeholders in education development in Tanzania. Although the government still largely shoulders the cost of education, parents have a part to play. Indeed, apart from school uniforms, exercise-books, and other needs, parents and/or guardians also buy books for their children. As one female parent, who is also a member of one primary school committee, observed:

> I, as a parent, have taken measures…to buy school requirements such as books to provide her or him with additional help where there some difficulties and to help provide additional information on educational matters as well as provide any other help to ensure that she or he can further advance her or his learning in addition to being close with her or him as part of facilitating her or his education… (Female parent, school committee member, Iringa rural).

The experience of this parent suggests that some parents do buy books for their children. But this did not apply across the board as some children reported that, because of economic constraints, their parents did not buy books for them. The following dialogue with one male pupil from in Iringa urban on whether parents can be used for illustrative purposes:

Interviewer : … at home, do parents buy books for you to read?

Interviewee pupil : No

Interviewer : What do you think is the reason?

Interviewee pupil : "…because the money is always not enough while the responsibilities are many.

Research findings indicate that there are two categories of parents and/or guardians: Those with enough resources to buy school books for their children and those too poor to afford them. Indeed, as indicated elsewhere, the majority of poor parents failed to buy books despite having the desire to buy books for children—they were just too poor to afford them.

Setting time for them to read Some parents and/or guardians reported setting aside some time for children to read books. Usually, this practice took place in the evening after the children had returned home from school. However, this approach to reading was not realistic for the majority of girls in poor households as indicated elsewhere. In some households, time for girls or children generally to read books was spent on undertaking house chores and other income generating activities. Similarly, there were poor families who found buying books for their children a luxury as they survived largely by hand-to-mouth. Such children only read notes given by teachers at school whenever they had some time to spare.

What challenges do schools experience in promoting book reading habit?

The question of the challenges primary schools encounter in cultivating reading habits among pupils required the informants to identify the challenges that the school teachers and parents, as stakeholders encounter in fostering pupils' reading habits. Several different challenges emerged: Pupils' low interest in books; lack of books; lack of libraries; pupils' illiteracy; high cost of books; and lack of push from teachers.

Pupils' low interest in reading books

Teachers in all the schools under review raised concern over the pupils' low motivation or interest in reading books. During conversations, teachers were asked to identify indicators of pupils' low interest in reading books. To begin with, teachers said that the pupils were not reading books on a regular basis while in school premises. Observation of pupils' lack of habitual reading of books outside classroom hours was independently verified during school visits. During breaks, some of the pupils were either having a siesta or engaged in idle talk. Others were busy with sports and games. Moreover, pupils did not make use of the few old books available in school book stores that also served as teachers' offices. In some schools, it was observed that all the books found in "book stores" were outdated; and some of them had not been read or opened since the 1970s.

Lack of books

During interviews, it was established that schools did not have books for pupils to read on their own during their free time. Indeed, the shortage of books was a problem faced by all schools involved in the study. This finding implies that even when pupils had a high interest in reading books they would be frustrated by the sheer absence of updated, topical and relevant books. The shortage of books in primary schools is attributable to district councils' incapacity to supply them with relevant books. This problem has a long-standing

history in Tanzania. Chonjo (1994) drawing on the experience of Tanga Municipality sums up this dire situation thusly: "There was not enough money given by Municipality to pay for enough books for the schools" (p. 41). Neither can the majority of pupils find respite at home. Indeed, only few parents who are financially capable can buy books for their schooling children particularly those that cultivate a genuine thirst for reading. Financial constraints aside, some parents did not even appreciate the value of the book reading habit among their children due to their low level of education. As a result, these parents treated buying books for children as an unnecessary burden.

Lack of libraries

The library was another challenge that teachers or schools had to contend with in efforts aimed to promote pupils' book reading habits in the primary school. In conversations with the teachers and pupils, it was established that none of the primary schools under review had libraries, whether makeshift or otherwise. As noted elsewhere, schools did not have infrastructures to serve as libraries. Instead, most of the primary schools in the research sites had stores for keeping books. Lack or shortage of libraries remains an entrenched problem in virtually all government-run primary schools in the country. This finding is in line with Magava (2009) who found that out of six primary schools in Iringa none had a library. Indeed, this experience goes against Tanzania's Education and Training Policy, which categorically stipulates that the Tanzanian Library Services shall promote and develop, among other things, school libraries (URT, 1995). Even more worrying was the fact that although some primary schools in the research sites had book stores, pupils did not access them. They were afraid of requesting these books from their teachers. To compound the problem, some pupils were in the dark about the existence of these book stores.

Pupils' illiteracy

For quite some time now, parents and/or guardians have been complaining of pupils who can hardly read and write despite having completed the primary education schooling cycle (Anangisye, 2010). This state of affairs has been evident in some of the primary schools located in several parts of the country. In the field, there were pupils in Standard VII (class seven) —the final stage of the primary school cycle—who could neither read nor write. Indeed, during conversations, teacher informants raised serious concerns about pupils' illiteracy to explain difficulties that schools encountered in their attempt to promote reading habits among pupils in their respective primary schools. As a result of illiteracy and semi-illiteracy, there was little that teachers or schools and parents could do to help such pupils cultivate the habit of reading. In comparison, the problem of illiteracy was more pronounced in rural-based than urban-based primary schools. The difference is attributable to, as suggested by empirical studies, the shortage of qualified teachers in rural-based schools (Saunders, 2000) as well as lack of funding and SES of parents.

High cost of books

For some informants, the high cost of books hindered the development of pupils' reading habit. During interviews, teachers and parents cited financial constraints as a

hindrance to initiatives aimed to promote pupils' reading habit. Like elsewhere in the developing world, parents, especially those from economically and socially disadvantaged groups, have problems in determining whether to buy books for school children at the expense of meeting basic household necessities. "…the economic situation makes it difficult for me to buy the books that she needs, as some are too expensive to afford …" (Male Parent, Rungwe district). For many families, books for children are secondary and, hence, non-essentials. Yet, the problem of the cost of books does not only affect families. Despite its concerted efforts, the Tanzanian government has not succeeded to fully ensure that all schools, colleges and universities are adequately supplied with the books they need for various disciplines. The high prices for books coupled with the poor state of the country's economy explain why educational institutions lack essential books necessary to promote a reading culture. Consequently, all levels of education go without not only required and but also updated books. The problem is compounded by the fact that a good number of books require foreign currency as they are imported from abroad.

Lack of push from teachers

As indicated elsewhere, teachers in primary schools have a significant role to play in cultivating and promoting pupils' book reading habits. Although teachers encouraged pupils to read books, the study found that they did not push pupils enough to encourage them to love to read books on a sustainable basis. As one teacher participant explained:

> Pupils' desire to read is not that much big precisely because as teachers we have not given the pupils enough push to encourage them read books. As a matter of fact, if you go to a school book store you will find that half of the books have never been read; and are no longer relevant to the present curriculum (Male teacher, Iringa Urban).

The implication is that teachers must serve as models to encourage pupils to read and reap maximum benefits. But, the question is whether or not teachers have the means to encourage pupils in schools to develop the much needed reading habit. Here, authority may imply a number of things such as the attitude of the teachers towards reading books; teachers' little appreciation centralising the reading books among pupils; and the lack of updated, topical and relevant books in schools that can catalyse pupils to become ardent readers. Arguably, unless teachers have a sense of book culture and are aware of their obligation to the pupils, they can hardly push them towards embracing the habit of reading books.

Discussion of findings

In principle, every stakeholder in the education industry, especially in the developing world, agrees that primary education is central to laying the foundations of children's education. In many developing countries, especially in Africa, children are initiated into the habit of reading the first day they are enrolled in primary school (Nyerere, 1968). Primary one is the turning point for many children in Africa. This level of education marks the beginning of literacy and numeracy—learning to read, write and arithmetic (3Rs). The pupils' world of interaction with books or literary works begins here. Primary schools have always sought, for this level of education, teachers with rich skills and experience in

teaching (Murutu, 1979). However, while this is supposed to be the case, in practice there are problems that make the process of cultivating the habit of reading among school pupils difficult. In this study, teachers, parents and pupils did not have the idea of a library where they could borrow books. This is because the schools did not even have libraries and the small number of books supplied to the schools ended up rotting in school book stores largely unused, with many of them outdated. Moreover, schools did not have a proper mechanism for enabling pupils borrow and actually read books. The situation was even worse in rural-based primary schools.

Teachers and parents, who are supposed to nurture the habit of reading books among pupils, ironically did not have a reading habit themselves. At home, parents were busy with other things as reading was alien to them. In many households, the reading environment was so poor that promoting a reading habit was not possible. Worryingly even teachers, who were supposed to be in the vanguard, also did not have the habit of reading books. As a result, pupils lacked a book reading habit model to emulate either at school or at home. Without a solid base, measures that schools take to cultivate pupils' reading habit are likely to be futile. Comparatively, pupils in rural-based primary schools were more disadvantaged than their counterparts in urban-based schools. Pupils in urban-based schools had the privilege of accessing library services, which were readily available at various levels for pupils keen on reading books. Pupils in rural-based schools, on the other hand, had no access to library services to frequent.

Conclusions and recommendations

Based on the findings, the following conclusions are made. To begin with, there was evidence that stakeholders generally understood the concept of reading habit. Thus, if school children failed to develop the reading habit it was largely because of a lack of reliable, viable and feasible initiatives. Also, the initiatives that primary schools have employed to cultivate pupils' reading habits to-date appeared largely unrealistic and cosmetic. The impracticality of the initiatives is based on a number of facts. First, teachers, parents and stakeholders who were supposed to cultivate the reading habit among school children did not themselves have the habit of reading books. As a result, children at school and home lacked reading models to emulate. Second, a lack of resources and infrastructure hindered the mission to promote pupils' habit of reading. Perhaps, surprisingly, none of the schools involved in the study had a library that would have created a facilitative environment that stirred and cultivated the habit of reading in pupils. It is arguable that if primary schools have failed to ground children in good academic habits, then there is a danger of most of them progressing to post-primary education levels without having developed the reading habit, thus jeopardising their opportunities to successfully and actively participate in formal education processes. Third, to many pupils reading books is highly associated with examinations (Owusu-Acheaw & Larson, 2014). They read—actually studied—at school or home simply to prepare for examinations or tests. What is lacking is reading for the sake of one's new enjoyment and one's knowledge development in most of the selected primary schools.

Strategically, the promotion of a reading habit must actually begin with parents and/or guardians at home. Indeed, parents are the immediate models for children. When parents are not good book reading habit models for children to emulate, schools remain the only

possible forums for such nurturing. Unless parents and/or guardians are well-versed with the concept of the reading habit they can hardly contribute to the development of children's reading habit. Thusly, creation of parents' awareness of the concept and importance of reading habit is needed. Indeed, like children in Scotland or elsewhere in developed countries (Nyerere, 1968), every child in Tanzania and elsewhere on the African continent has a right to be encouraged by schools or teachers to develop a reading habit. As Camp (2007, p. 252) puts it, "... all teachers must encourage and model the habit of lifelong reading..." In this regard, specifically, reading lessons, class libraries and reading programme clubs should be introduced and made compulsory at all grades of primary education. Indeed, like EFA campaigns, the Government of Tanzania, the international community and other partners should promote children's literature; and provide schools with books and other literary works. But for schools to succeed in this mission there must be deliberate efforts, including launching country-wide campaigns, aimed at sensitising the nation on the importance of developing a life-long reading culture for primary school pupils. Like the campaigns for HIV and AIDS education, reading habit crusades must begin with nation down to regions, districts, divisions, wards and villages. In the same vein, efforts to revive the Tanzania Library Services are necessary. Apart from strengthening the current infrastructures, mobile library services should be given high priority to ensure no stone is left unturned to develop the habit of reading books amongst pupils in Tanzania and elsewhere in Africa. Last, but by no means least, it is high time for the educational authorities in Tanzania and in developing countries elsewhere to consider the establishment of school competitions to promote reading habits and other reading materials. The reading habit competitions may start at the school level by involving classes. Gradually, the competitions should involve schools at village, county, division, district and then regional or provincial levels. The pupils' reading habit competitions should be organised by the relevant authorities at each level. For effectiveness, the competitions may be scheduled to take place once in three years. The three-year term will provide an opportunity for schools at all levels to have time to prepare pupils for the competitions.

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Investigation of the relationship between students' academic achievement and schools' leadership capacity: An analysis of lower secondary schools in Turkey

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Abstract

The purpose of this study was to determine lower secondary school students' academic achievement based on the leadership capacity of schools. The relational survey model was applied using a Turkish adaptation of the Leadership Capacity School Survey with a sample of 1836 students and 525 faculty and staff at 17 schools. The Study found that the leadership capacity of the schools was above average. Results of the Hierarchical Linear Modeling analysis revealed a significant difference among the schools in terms of students' achievements of graduation and transition to upper secondary schools. Moreover, the research revealed that schools' leadership capacity predicted students' achievements in graduation and transition to upper secondary schools. The implications of the study were that the leadership competency of educators should be improved through pre-service training at faculties of education for teacher candidates and in-service training carried out by the Ministry of National Education for teachers.

Keywords: Leadership capacity, academic achievement, lower secondary school, TEOG exam, Turkey

Introduction

In the history of humankind, the school is one of the most important forms of organizations that prepares individuals for the future. Notwithstanding the criticisms of the school (Apple, 2004; Althusser, 2006; Bourdieu, 2005; Bowles & Gintis, 1996; Freire, 2010; Gardner, 2008; İnal, 1996, 2004; Schlechty, 2014; Ünal, 2005), the debates on deschooling society (Illich, 2006) and the predictions that schools in their current form will disappear in the future (Ellis, 2005; Hesapçıoğlu, 1996; Tezcan, 1998), there is barely any other form of organization that is so decisive in the life of individuals and in their construction of the future. The survival of the institution of the school and its longevity through human history are based on its contribution at both the individual level, community level and to society as a whole. Whether or not the school or the education system achieves its objectives is of vital social importance. Therefore, achieving the objectives by educational organizations is one of the main agendas of the societies, which should be thought of both individually and socially.

The basic indicator of school performance is the degree to which the individuals and social needs are met and the level of acquisition of basic skills (Balcı, 2014; Berberoğlu & Kalender, 2005; Eğitim Reformu Girişimi [ERG], 2009; TEDMEM, 2016). Revealing and developing each individual's potential and turning it into a competency are among the individual objectives of education while nurturing individuals who comply with the needs of the economic, political, and social systems are the social objectives. However, the dual individual or social objectives of education can also be considered as an artificial form of classification because, in education, individual goals and social goals are intertwined. Without achieving individual goals, social goals cannot be achieved or vice versa. Therefore, although the academic success or failure of the individual seems to be an individual outcome, it is a social outcome and a social problem. This problem concerns both the family at the micro-level and the government at the macro level and requires a common effort.

There are many national and international indicators showing whether the school has achieved its goals. These indicators can be grouped as quantitative and qualitative. The most common quantitative indicator is academic achievement. When academic achievement is mentioned, it generally refers to indicators that were developed in the education system and which measure the skills or knowledge gained by the child, which are translated into a numerical score through various assessment methods (Carter & Good, 1973 as cited in Durmuşçelebi, 2013). National indicators of academic achievement include examinations conducted at a central level which usually regulates the transition to an upper education level as well as grades indicating whether a class has been passed or failed. International indicators, on the other hand, involve exam assessments that enable international comparisons such as the Programme for International Student Assessment (PISA) that evaluates science, math, and literacy skills, Trends in International Mathematics and Science Study (TIMSS) that evaluates math and science skills, and the Programme for the International Assessment of Adult Competencies (PIAAC) that evaluates the adult competencies. Both national and international indicators reveal important findings related to students' academic achievement in Turkey. For example, 50,850 students in 2012 (Mynet Web, 2012, April 20) and 38,483 students in 2017 (Hürriyet Web, 2017, March 28) achieved a score of zero from the Transition to Higher Education Examination (THEE). Furthermore, 420,000 students did not give a single correct answer to the questions in the 40-item math

test in 2014 while this number rose to 900,000 students in the science test (Kıvanç, 2014, April 7). Therefore, the national indicators show that there is a problem regarding academic achievement in Turkey.

International indicators regarding academic achievement do not suggest bright future for Turkey. Exams such as TIMSS since the second half of 1990s and PISA since the 2000s show that Turkey had a poor ranking at the international level (Anıl, Özer Özkan, & Demir, 2012; Organization for Economic Co-operation and Development [OECD], 2010; Ministry of National Education [MoNE], 2016; Mullis, Martin & Loveless, 2015). The 2015 results of the PIAAC, through which OECD evaluates literacy, numeracy, and problem-solving in technology-rich environments of adults between 16 and 65 years old are similarly discouraging as Turkey's PISA and TIMSS results. According to the PIAAC results, adults in Turkey performed worse than the OECD average in the areas of literacy, numeracy, and problem-solving in technology-rich environments. According to the report, the rate of adults who had achievement at level 1 or lower was 45.7% for literacy and 50.2% for numeracy. The rate of adults achieving the highest level was just 0.5% for literacy and 1.5% for numeracy. When the findings regarding the problem-solving skills in technology-rich environments were examined, 55.6% of the adult population had no computer experience and computer-based test experience or failed the most basic test. Just 0.9% of Turkish adults achieved the highest PIAAC level (TEDMEM, 2016). Another indicator that can be used to assess the quality and achievement of education in Turkey is the labor productivity level. According to 2015 purchasing power parity data, the value produced by one worker in one hour of OECD countries was approximately 51USD on average while this value was about 32USD in Turkey (OECD, 2017a). The OECD average of labor share for low-skilled workers was 23% while it was 51% in Turkey (OECD, 2017b). All of these findings are significant since they show that the educational structure of the population is not appropriate for the development and progress of Turkey, which is a significant social problem.

Students who fail in the education system are likely to repeat the class or leave the system (United Nations International Children's Emergency Fund [UNICEF], 2013). In countries where class repetition is high, the general achievement level of students tends to decrease (OECD, 2011). Therefore, whether it results in class repetition and dropout or developing individuals without adequate competencies, academic failure has costly outcomes for both the individual and society. For example, the cost of a one-time class repetition of students in Turkey was estimated to be approximately 125 million USD (UNICEF, 2013).

The relevant body of research posits numerous variables that may predict student achievement. It is possible to classify these variables into different categories. In the current study, these variables were classified into three categories. These categories are individual variables, family or socio-economic variables, and organizational variables. The individual and family variables are independent of the school, while the organizational variables arise within the school. When the literature regarding academic achievement was reviewed, it was observed that individual variables were investigated more than the family and organizational variables. The individual variables identified in the literature included students' intelligence and skills (Eski, 1980; Yıldırım, 2000), gender (Bahar, 2006; Duckworth & Seligman, 2006; Kılıç & Karadeniz, 2004; Mau & Lynn, 2001; Pomerantz, Altermatt & Saxon, 2002), self-confidence, motivation, personality traits (Keskin & Sezgin, 2009; Yıldırım, 2000), learning styles, attitudes towards a program or lesson/content (Oliver & Simpson, 1988; Pehlivan & Köseoğlu, 2010; Skouras, 2014), school starting age (Küçüker, 2016), study

habits (Kara & Gelbal, 2013; Smith & Niemi, 2001), relationships with family and teachers (Harding, 2003; Huang, 2008), and test anxiety (Akın, 2008; Austin & Partridge, 1985; Birenbaum & Nasser, 1994; Cassady, 2004; Hancock, 2001).

Socio-economic variables have been examined less often than the individual variables; however, their effects on academic achievement have been constantly emphasized. This category involves variables defining the socio-economic level of the family. They include variables such as family income, education expenses for the children, employment status and occupations of parents, educational status of the parents, number of children in the household, the number of children going to school in the household, environment and affordances provided to children, status of going to private teaching institutions, status of getting private lessons, parents' marital status, etc. There are studies focusing on the relationship between family or socio-economic variables and academic achievement (Acemoğlu & Pischke, 2000; Aslan, 2017; World Bank [WB], 2013; Eamon, 2005; Gelbal, 2008; Hochschild, 2003; Jeynes, 2013; Johanningmeier, 2008; Oral & McGivney, 2014; Öksüzler & Sürekçi, 2010; Sawkins, 2002; Sirin, 2005; White, 1982; White, Reynolds, Thomas & Gitzlaff, 1993; Yelgün & Karaman, 2015). Bourdieu (2005 as cited in Aslan, 2017) describes family variables that have the potential to affect each other as the socio-cultural capital of family and argues that it is decisive in students' academic achievement. Bourdieu argues that it is social class that determines the students' academic achievement rather than personal characteristics and abilities because the school accepts and transmits the cultural capital of the higher social codes. For this reason, students with these codes are more successful in school. Coleman (1988) focuses on the factors arising from the school and family. He argues that schools are not able to make a difference for most of the students and can make only slight differences for minority groups and disadvantaged students (Balcı, 2014). According to Coleman (1988, p. 108 as cited in Güllüpınar & İnce, 2014), the fundamental factor that plays a role in academic achievement is "family background." Family background has three different components; financial capital, human capital, and social capital. Coleman asserts that these three forms of capital are decisive in explaining students' academic achievement. However, financial and human capital are not significant unless they are transformed into social capital. Therefore, the advantaged families are those who have financial, human, and social capital and use them effectively (Coleman, 1988).

In the literature examining the organizational variables, "effective school" studies that have been carried out since the 1960s in developed countries are commonly focused on equality of educational opportunity studies (Aslan, 2017). The studies investigate the effects of factors influencing achievement that arise from the school. Establishing organizational variables requires a comprehensive dataset including the physical infrastructure of the school, administrator and teacher competencies, educational programs, and school types. Among them, the environment and opportunities provided by the school, teacher competencies, and school type have been frequently studied within the organizational dimension (Berberoğlu & Kalender, 2005; Celkan, 1983; Darling-Hammond, 2000; Kavak, Aydın & Akbaba-Altun, 2007). The most significant finding of effective school studies is the major impact of the school on academic achievement in developling countries (Balcı, 2014). The most remarkable research among effective school studies is a study carried out by Heyneman and Loxley (1983 as cited in Aslan, 2017). Their study analyzed data from 29 countries grouped into low and high-income subsamples, finding that opportunities provided by the school were more decisive in students' academic achievement than personal characteristics.

According to Hoy and Miskel (2010, pp. 39-81), learning and teaching functions are the technical foundation of the school. The school is there to achieve that function. The technical function requires ensuring student achievement and monitoring student development. Ensuring student achievement and monitoring the development are among the responsibilities of both administrators and teachers. The concept of leadership has been a matter of debate since the 1950s. A leader is defined as someone who has the ability to convince employees to make an effort in line with the predetermined objectives so that the organization can achieve its goals (Davis, 1988). Within this context, achieving school goals and making students successful are seen as the primary duty of school leaders. Studies building the relationship between students' academic achievement and leadership competencies of administrators have been undertaken since the 1990s and acknowledged as the new era of effective school studies. Among the characteristics of effective schools in new era research, leadership roles of school administrators have been emphasized (Levine & Lezotte, 1990; Mortimore et al., 1988; Reynolds, 1993 as cited in Balcı, 2014, pp. 23-24). The literature involves studies on the relationship between the leadership of school administrators and students' academic achievement (Davis, 2009; Gentilucci & Muto, 2007; Gilson, 2008; Heck & Hallinger, 2009; Leithwood, Harris & Hopkins, 2008; Leithwood, Patten & Jantzi, 2010; Marks & Printy, 2003; Nettles & Herrington, 2007; Rivers, 2010; Robinson, Lloyd & Rowe, 2008; Ross & Gray, 2006; Witziers, Bosger & Krüger, 2003).

The research and debates about which leadership approach is best for achieving school goals have been ongoing. However, due to the nature of the work done in the school, the education process requires a collective effort and it is not a task that school administrators can achieve on their own. In fact, the complex nature of the school, the intensification of the demands made on and by the school, and the increase in the expectations from the school administrators cause the leadership of the school administrators to be inadequate for a sustainable school development (Kılınç, 2013). For this reason, the school principals' leadership skills alone may not be enough to ensure the development and effective maintenance of the school (Marzano, Waters & McNulty, 2005). In this context, one of the concepts that has recently emerged is the school's leadership capacity. Youngs and King (2002) define the concept of school capacity as the collective power of educational employees to increase student achievement in school. Increasing school capacity can be decisive in achieving school goals.

Harris and Lambert (2003 as cited in Kılınç, 2013, p. 57) consider the development of organizational capacity as an investment in the human resources of the organization and particularly in the professional development of the members of the organization. The school's leadership capacity emphasizes the leadership potential of the individual and the organization collectively. In this respect, it differs from the traditional leadership concept and links the development of the learning and teaching process at school with the leadership of all members of the school. This means that the traditional approach, which confines leadership to the school administrators, is transformed into a contemporary understanding that is shared among all the education parties in the school and allows the leadership of the followers. A similar emphasis was also made by Ledbedder (2007 as cited in Kılınç, 2013, p. 5). Ledbedder argues that a school's leadership capacity is composed of all employees who assume the leadership role and that the development of the school's leadership capacity is necessary for school development. According to Lambert, the dimensions of leadership capacity are broad-based and skill-based participation in leadership process, shared vision that provides program integrity, research-based data usage

in decisions and practices, role and behaviors reflecting wide participation, cooperation and shared responsibility, reflective practices leading to innovation, and high and increasing student achievement and development (Lambert, 2003 as cited in Kılınç, 2013, p. 44).

The evidence that in-school factors, including leadership, influence academic achievement in low income and developing countries motivates the present study. The existing literature on academic achievement and leadership at schools have made this study significant for two reasons. Firstly, each variable that has an effect on an academic variable is important whether it is in-school or out-of-school. Doubtless there are some measures that can be taken in terms of individual and family variables; however, most of them require long-term social and economic policies. Within this context, with reference to research on effective schools, in-school organizational variables that are considered to have an effect on achievement are seen as easier to intervene on. Secondly, theoretical studies are dominant among school-centered leadership research and empirical studies are relatively less common. It can also be seen that the majority of empirical studies try to determine administrators' and teachers' views or perceptions regarding the various leadership approaches. Therefore, the current study focuses on the relationship between schools' leadership capacity, which is among the theoretical variables, and academic achievement. For the first time in Turkey, the school leadership capacity's relationship with student achievement of graduation and transition to upper secondary schools is examined. Academic achievement is a multifaceted phenomenon and is affected by many variables. Any variable that has the potential to affect academic achievement with individual and social consequences is worth investigating and justifies the present study. The research aims to guide educational policymakers and the leaders as they seek to contribute positively to the academic achievement of the students, and ensure the development of the school.

Research objectives

The purpose of this research was to determine lower secondary school students' academic achievement (graduation and transition to upper secondary schools) based on the leadership capacity of schools. Within the scope of this purpose, the following research questions was addressed: (i) What are the opinions of administrators (school principals and vice-principals) and teachers regarding the dimensions of leadership capacity? (ii) Does the students' academic achievement (graduation and transition to upper secondary schools) significantly differ between schools? (iii) Do the leadership capacity of schools, their size, and their location predict the students' achievement (graduation and transition to upper secondary schools)?

Method

This descriptive study aimed to investigate lower secondary school students' academic achievement (graduation and transition to upper secondary schools) based on the leadership capacity of schools. Thus, a relational survey model design was applied, one of the general survey models. Survey models are the research models which "aim at describing past or present situation as it is" (Karasar, 2011). In the current study, schools' leadership capacities

were determined based on the opinions of teachers and administrators and were associated with students' academic achievement.

Population and sample

The target population of the research involved 2,858 teachers working at lower secondary schools in Tokat during the 2016-2017 academic year and the principals, vice-principals, and eighth-graders of these schools (MoNE, 2017). The sample size that could represent the population with a 1% error margin was at least 545 participants (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2012, p. 98). Stratified two-stage sampling was used. The first stage involved schools. Teachers and administrators working at these schools and eighth-graders studying at these schools constituted the second stage. New schools were included in the research until the predetermined sample size was reached. During the inclusion of the schools into the stratum, schools with different settings and opportunities, different socio-economic backgrounds, and mobile centers were purposively sought. The schools were homogenous in terms of some characteristics such as students' socioeconomic levels and other school-related variables. However, they were different in terms of size, location or school type (public-private). The survey was administered with 600 participants in case of erroneous filling of the measures, missing values, or not reaching the adequate number. Ultimately, 525 responses were usable and were included in the analyses. Two different datasets were used in the research. The data regarding the leadership capacity were obtained using the "Leadership Capacity School Survey (LCSS)", which was adapted into Turkish by Kılınç in 2013. The data regarding the academic achievement of eighth-graders were obtained from schools. The eighth-graders were intentionally chosen because the research involved the achievement of transition to upper secondary schools and their graduation GPA covered the academic achievement of all grades. The analyses were carried out using data from 17 schools, 525 teachers and administrators and 1,836 students. No data other than graduation and transitions to upper secondary school scores were gathered from students. Descriptive information regarding the participants (administrators, teachers) and schools can be seen in Table 1.

Data collection tool

The "Leadership Capacity School Survey" was used as the data collection tool in the research. The survey was adapted into Turkish by Kılınç (2013). The survey involved 30 items aiming at determining the leadership capacity of the schools. In addition, it involved eight items to reveal the personal information of the participants. For the whole scale, the reliability coefficient was .87 (Spearman-Brown), the internal consistency coefficient was .97 (Cronbach Alpha), and Guttman's split-half coefficient was .87 (Kılınç, 2013, p. 95). The content validity of the scale was ensured through expert opinions by Kılınç (2013). Moreover, the items were examined by an expert on measurement and evaluation within the scope of the current study, and they were approved. The 30 items consisted of four dimensions. The dimensions are "Distributed Leadership" (1-7 items), "Shared School Vision" (8-16 items), "Collaboration and Collective Responsibility" (17-22 items), and "Perceived Student Achievement" (23-30 items). The reliability coefficients of distributed

Table 1. Some descriptive information about participants and schools

Variables		*f*	%	Variables		*f*	%
Variables regarding participants							
Gender	Female	261	49.7	School affiliation	Public	467	89.0
	Male	264	50.3		Private	58	11.0
	Total	525	100.0		Total	525	100.0
Experience	1-10 years	193	40.5	Title	Principal	20	3.8
	11-20 years	179	37.5		Head vice-Principal	3	0.6
	21 and over	105	22.0		Vice-Principal	28	5.3
	Total	477	100.0		Teacher	474	90.3
					Total	525	100.0
Variables regarding schools							
Location	Village/Town	6	35.3	School size	0-500 students	9	52.9
	City	11	64.7		501-999 students	5	29.4
	Total	17	100.0		1000+ students	3	17.7
School types	Public	15	88.2		Total	17	100.0
	Private	2	11.8				
	Total	17	100.0				

leadership, shared school vision, collaboration and collective responsibility, and perceived student achievement were .89, .90, .88, and .90 (Spearman-Brown), respectively. The internal consistency coefficients were .91, .94, .91, and .93 (Cronbach Alpha) while Guttman split-half coefficients were .87, .90, .88, and .89 (Kılınç, 2013, p. 95). Each item is rated on a four-point Likert scale indicating "We do not do this at our school", "We are starting to move in this direction", "We are making good progress here", and "We have this condition well established".

The second dataset involved students' achievement of graduation (GPA) and transition to upper secondary schools (in Turkey, lower secondary students take a central test called TEOG during graduation and are placed to upper secondary schools based on their scores). In the current research, the criteria of students' achievement involved their graduation scores (GPA) and TEOG scores (achievement of transition to upper secondary school). When the graduation process was finalized in the schools and TEOG results were announced, students' graduation and TEOG scores were obtained with the permission of school administrations. Students' graduation and TEOG scores were obtained according to their school numbers rather than their identity information. By this means, their anonymity was ensured. The survey was administered by the researcher simultaneously at all schools during April-May 2016.

Variables

Since the purpose of this study was to reveal the effects of leadership capacity of schools on students' achievements of graduation and transition to upper secondary schools, no variable at student level was included in the analyses. The dependent variables of the study were graduation and TEOG scores while the independent variables were leadership capacity of the schools that were determined based on the opinions of administrators and teachers, school size that was determined based on the number of students, and location of schools.

Data analysis

The collected surveys were coded by the researcher and transferred to a computer. SPSS 22.0 software was used for organizing and analyzing the data while HLM 8.0 software was used for testing the hierarchical linear model. Prior to the analyses, the data were inspected in terms of missing values and outliers. Considering the research purpose, it was seen that the research data had a hierarchical structure. The research involved two types of variables that were school-related and student-related. The schools involved students. Moreover, the characteristics of schools and students could vary. However, students could also be affected by the characteristics of their schools.

The following steps were taken during the analyses. (i) The mean and standard deviation values of leadership capacity dimensions of the schools were estimated using SPSS 22.0 package program. Thus, the opinions of the participants regarding the leadership capacity of the schools were determined. (ii) For the purposes of this study, a different hierarchical model was used for each objective. Accordingly, a one-way ANOVA with random effects was used to test whether there was a significant difference between schools in terms of graduation and TEOG scores of the students, which addressed the second objective of the study. Means as outcomes regression model was used for the third objective. The models that were used for each objective of the study were repeated for graduation and TEOG scores. The findings were presented together so that the comparisons could be made more easily. (iii) Prior to HLM analyses, assumptions were tested. Accordingly, the assumptions of two-level hierarchical linear models were as: normality of error terms for Level-1, Level-1 units demonstrate normal distribution in which the mean of each Level-1 error terms equals zero. Level-1 variables are independent of Level-1 errors. Level-2 demonstrates multivariate normality in which the mean of errors is zero. Level-2 predictors are independent of Level-2 errors. The errors of Level-1 and Level-2 are independent of each other. Predictors at each level are not related to random effects at other levels (Raudenbush and Bryk, 2002 as cited in Acar, 2013, p. 54). Before the analyses, multicollinearity and abovementioned assumptions were tested for each dataset and it was concluded that the assumptions were met.

Findings

In this section of the study, the research questions are presented in line with the research objectives.

Findings regarding the participants' opinions about the dimensions of leadership capacity

Participants' (principals, vice-principals, and teachers) opinions about dimensions of leadership capacity are presented.

Table 2. Descriptive statistics of leadership capacity levels

Dimensions	*N*	Minimum	Maximum	$\overline{X}$	*sd*
Distributed Leadership	525	1.29	4.00	3.13	0.64
School Vision	525	1.11	4.00	3.18	0.61
Colla. and Collec. Res.	525	1.17	4.00	3.30	0.60
Perceived Achievement	525	1.63	4.00	3.31	0.57
Total Leadership Cap.	525	1.40	4.00	3.23	0.56

Table 2 indicates that perceived student achievement had the highest score (X = 3,30) and distributed leadership had the lowest score (X = 3,13). Standard deviation values indicate that perceived achievement had the most homogenous distribution (sd = 0,57) while distributed leadership had the most heterogeneous distribution (sd = 0,64).

Findings regarding the determination of the difference among schools in terms of students' graduation and Transition to Upper Secondary Schools (TEOG) scores

The second research objective concerned whether the students' academic achievement (graduation and transition to upper secondary schools) and whether it significantly differed among schools. To address this objective, a one-way ANOVA with random effects, one of the hierarchical linear models, was used. In the equation estimating graduation or TEOG achievement (M_{ij}= graduation; T_{ij}=TEOG) of student i at school j, β_{0j} refers to graduation or TEOG achievement mean of school j while r_{ij} is interpreted as the difference of graduation or TEOG achievement of student i at school j than the graduation or TEOG achievement mean of school j. Named as the intercept coefficient, β_{0j} is the fixed-parameter and r_{ij}, named as the level one error term, is the random parameter in the model, and it is assumed that this parameter demonstrates normal distribution with mean 0 and variance σ^2. In the equation in which the intercept coefficient (β_{0j}) at level one of the model is used as the dependent variable, γ_{00} refers to the general graduation or TEOG achievement mean while u_{0j} is interpreted as the difference of graduation or TEOG achievement mean of school j than the general graduation or TEOG achievement mean. It is assumed that the u_{0j} parameter, named as the level two error term, demonstrates normal distribution with mean 0 and variance τ_{00}. Accordingly, the following models were found. As a result of the one-way ANOVA, estimation of fixed effects is presented in Table 3.

Level-1Model $(M_{ij} \mid T_{ij}) = \beta_{0j} + r_{ij}$

Level-2 Model $\beta_{0j} = \gamma_{00} + u_{0j}$

Mixed Model $(M_{ij} \mid T_{ij}) = \gamma_{00} + u_{0j} + r_{ij}$

Table 3. Estimation of fixed effects of one-way ANOVA with random effects model

Achievement		Coefficient	*SE*	*t*
Graduation	For Coefficient β_{0j}, Average School Mean, γ_{00}	82.83	1.83	45.29*
TEOG	For Coefficient β_{0j}, Average School Mean, γ_{00}	365.94	11.31	32.36*

* $p < .001$

Table 3 shows that school means significantly differed from zero in terms of graduation and TEOG means. It was observed that the school means that were involved in the analyses differed significantly ($t_{graduation}$ = 1.83, $p < .001$, t_{TEOG}=11.31 $p < .001$). Accordingly, considering the 95% confidence interval for general graduation achievement, it can be stated that the general graduation achievement mean in Tokat province was in the range of 82.83 ± (1.96) (1.83)= 79.24 – 86.42 at 95% probability. As for TEOG scores, the real score range was in the range of 365.94 ± (1.96) (11.31) and the real scores ranged from 343.77 to 388.11 at 95% probability. Estimation of variance components of one-way ANOVA with random effects that were performed in line with the first research objective can be seen in Table 4.

Table 4. Estimation of variance components of one-way ANOVA with random effects model

Achievement		Standard deviation	Variance component	c^2	*df*	Explained percentage
Graduation	Average School Mean, u_{0j}	7.36	54.13	530.49*	16	0.29
	Level-1 Effect, r_{ij}	11.58	133.98			
TEOG	Average School Mean, u_{0j}	45.10	2034.03	377.88*	16	0.22
	Level-1 Effect, r_{ij}	84.11	7074.81			

* $p < .001$

Table 4 shows that the variance among the schools' graduation means was calculated as 54.13. At the student level within the school mean, the variance of students' graduation scores was estimated as 133.98. The significance of variability among schools (p-value < .001, df = 16) showed that there were significant differences among the lower secondary schools' graduation means in Tokat. The probable value range for school means was 82.83 ± (1.96) (7.36); in other words, the school means were in the range of 68.40 and 97.26 at 95% confidence. Based on this result, graduation scores of schools in the sample were in a wide range.

The variance among school means for TEOG was 2034.03. At the student level within the school mean, students' TEOG mean score was 7074.81 (Table 4). The significance of variability among schools (p-value < .001, df = 16) showed that there were significant differences among the schools' TEOG means in Tokat. The probable value range for schools' TEOG means was from 277.54 to 454.34 using the formula 365.94 ± (1.96) (45.10).

In order to determine how much of the variance in the graduation scores of the students stem from the difference between schools, the τ_{00} (variance component) estimation of the model for both levels is compared and the explained variance ratio index is obtained

(Hox, 1995). Accordingly, explained variance at β_{0j} is estimated using the following formula.

$$\rho = \frac{\sigma_{u0}^2}{\sigma_{u0}^2 + \sigma_e^2}$$

Considering the variance values in Table 4, the variance values explained for both success indicators were obtained. 29%(54.13/54.13+133.98) of the differences observed in the graduation scores were due to the difference in the average graduation scores between schools. In other words, 29% of the variance in the graduation scores of lower secondary school students were caused by inter-school variables and 71% were caused by in-school variables. Approximately 22% of the differences in TEOG scores (2034.03/2034.03+7074.81) were related to the average TEOG scores among the schools according to the explained variance ratios calculated for TEOG. Accordingly, 22% of the differences in TEOG scores of students were related to inter-school variables and 78% were related to in-school variables.

Another finding obtained from the results of One-Way ANOVA with Random Effects Model was the graduation and TEOG averages (β_{0j}) reliability coefficient estimation ($r_{graduation}$ = 0.95; r_{TEOG} = 0.94). These values showed that the sample means used in the analysis predicted the real school averages very reliably.

Findings regarding how much of the students' graduation and TEOG scores were predicted by the schools' leadership capacity scores

Means as Outcomes Regression Model was used to address the third research objective. In the model where the means are dependent variables, it is assumed that only the level 1 intercept coefficient (β_{0j}) changes randomly and the level 1 slope coefficients are not available. In order to explain the differences between the corrected school averages at the second level of the model, two descriptive variables, the size and location of the school were added to the model as well as the leadership capacity scores of the model. As the center of this study involved the relationship between the leadership capacity of schools and academic achievement, no student variables were used to explain the variation in level 1. Since the leadership capacity score that is among the school variables in level II is a continuous variable, grand mean centering was used. The school variables used to predict the graduation and TEOG scores were "School Leadership Capacity (OLK)", "School Size (OB)" and "School Location (OYY)". As a result of this analysis, the following models were established. The results of the analysis obtained from the model established at the school level are presented in Table 5.

Level-1Model $(M_{ij} / T_{ij}) = \beta_{0j} + r_{ij}$

Level-2 Model $\beta_{0j} = \gamma_{00} + \gamma_{01}*(OLK_j) + \gamma_{02}*(OB_j) + \gamma_{03}*(OYY_j) + u_{0j}$

Mixed Model $(M_{ij} / T_{ij}) = \gamma_{00} + \gamma_{01}*OLK_j + \gamma_{02}*OB_j + \gamma_{03}*OYY_j + u_{0j} + r_{ij}$

Table 5. Estimation of fixed effects regarding level II random coefficient model

	Fixed effect	Coefficient	Standard error	*t*-ratio	*df*
Graduation	General Achievement Mean, γ_{00}	82.790	1.17	70.971*	13
	OLK, γ_{01}	0.601	0.21	2.916*	13
	OB, γ_{02}	0.000	0.00	-0.029	13
	OYY, γ_{03}	3.044	4.22	0.721	13
TEOG	General Achievement Mean, $\gamma 00$	365.856	7.41	49.341*	13
	OLK, γ_{01}	3.443	1.30	2.641*	13
	OB, γ_{02}	0.010	0.02	-0.332	13
	OYY, γ_{03}	23.905	26.77	0.893	13

*$p < .001$

As can be seen in Table 5, it was found that the leadership capacity of the schools predicted the graduation and TEOG achievement significantly for both graduation and TEOG scores ($t_{graduation}$=2.916, $p < .001$; t_{TEOG}=2.641, $p <.001$). A 1% increase in the school's leadership capacity ratio results in an increase of 0.60 for graduation and 3.44 for TEOG. On the other hand, it was found that school size ($t_{graduation}$=0.029, $p >.001$; t_{TEOG} = 0.332, $p > .001$) and location ($t_{graduation}$ = 0.721, $p >.001$; t_{TEOG} = 0.893, $p >.001$) were not significant predictors of graduation and TEOG scores. The estimation of variance components of the Level II random coefficient model is presented in Table 6.

Table 6. Estimation of Variance Components of Level II Random Coefficient Model

	Random Effect	Standard Deviation	Variance Component	*df*	$\chi 2$
Graduation	School Mean, u_{0j}	4.532	20.535	13	222.501*
	Level-1 Effect, r_{ij}	11.575	133.973		
TEOG	School Mean, u_{0j}	28.297	800.746	13	158.986*
	Level-1 Effect, r_{ij}	80.478	6476.766		

*$p <. 001$

As can be seen in Table 6, the variance of students' graduation scores was estimated as 20.535 after adding the level II variables to the model. The inclusion of school-level variables in the model revealed that the amount of variance in graduation scores decreased to approximately 13.29% [20.535/(20.535+133.973)]. Accordingly, the variation in graduation scores is due to inter-school variables at a rate of 13%, and this variation between schools is random ($\chi 2_{graduation}$=222.501, df = 13, $p <.001$). The variance of the TEOG scores of the students was estimated as 800.746 when the level II variables were included in the model (Table 6). Additionally, the explained variance of the change in TEOG scores of students for the same model was calculated as 11.00% [800.746/(800.746+6476.766)]. This 11% difference in TEOG scores was found to be random ($\chi 2_{TEOG}$=158.986, df=13, $p <.001$).

The index of explained variance can be obtained by comparing the predicted variance values of two models for school graduation achievement means [(54.126-20.535) /54.126]=0.62. Accordingly, 62% of the inter-school variance in graduation achievement was explained by the average leadership capacity of schools. These values were [(2034.033-800.746)/2034.033]=0.61 for TEOG. Accordingly, 61% of the inter-school variance in TEOG achievement is explained by the average leadership capacity of the schools.

In the analysis of means as outcomes model as a dependent variable, reliability estimation for school graduation and TEOG averages is conditional reliability estimation. In schools with the same average leadership capacity, reliability was approximately $r_{graduation}$=0.89 for graduation achievement means and r_{TEOG} = 0.86 for TEOG means. These values showed that the sample means used in the analysis predicted the real school averages very reliably.

Discussion, conclusion, and recommendations

In this research, students' academic achievement was investigated based on their graduation and transition to upper secondary school (TEOG) scores by focusing on schools' leadership capacity, one of the in-school variables. Within the scope of the first research question, the opinions of administrators and teachers about the dimensions of leadership capacity (distributed leadership, shared school vision, collaboration and collective responsibility, and perceived student achievement) were examined. In the present study, it was found that schools' leadership capacity scores that were determined based on the administrators' and teachers' opinions were above average. It can be stated that this finding is positive in terms of school development because the priority of all countries, whether developed or developing, is to increase the quality of education and student learning (Özden, 1999). This is consistent with the view that schools need to be continuously improved (Schlechty, 2014; Senge et al., 2014). For schools to develop, the leadership capacities of schools needs to improve as supported in earlier studies (Gambini, 2011; Kılınç 2013; Lamber, 2005; Senge, 2006). According to a meta-analysis study conducted by Marzano et al. (2005) on 69 studies involving approximately 1.4 million students and 14.000 teachers, when the principals' leadership skills are increased from 50% to 99%, academic achievement increases from 50% to 72%.

In the present research, it was determined that perceived student achievement had the highest mean score (X = 3,31) while the distributed leadership had the lowest mean score (X = 3,13). The mean scores of collaboration and collective responsibility and shared school vision were 3,30 and 3,18, respectively. These findings are completely consistent with the findings of Kılınç (2013) who aimed to determine the leadership capacities of elementary schools. According to the Kılınç's mixed-method research, perceived student achievement had the highest mean score while the distributed leadership had the lowest mean score. It can be stated that the scores of distributed leadership are expected to be low because when the school administrators' authority and responsibility in Turkey are examined, it can be noticed that the school had the responsibility while the unitary had most of the authority. Therefore, the low scores obtained by the school administrators and teachers on the distributed leadership dimension can be seen as the result of the imbalance between authority and

responsibility, which reflects the centralized structure of the Turkish education system. Supportively, Bursalıoğlu (1991, p. 72) and Başaran (2008, p. 162) indicated that one of the most important problems of the Turkish education system was the imbalance between school administrators' authority and responsibility.

On the other hand, the relatively low distributed leadership scores of school administrators and teachers may indicate the continuance of traditional leadership understanding at schools. In line with this, studies on leadership have examined school principals' interpretation of leadership or have aimed to demonstrate that leadership is within the scope of principals' duty and responsibility (Akbaba-Altun, 2003; Buluç, 2009; Cemaloğlu 2007; Çelik, 1998; Karip, 1998; Şişman, 2011). The concept of leadership has undergone its own transformation and change. The understanding of organizational leadership has evolved from the leadership of one person to the leadership of all organization members. In this transformation process, those who adopt the distributed leadership approach emphasize the complex nature of educational organizations and argue that the school is too complicated to be led by only one person. In these studies, the collective or complementary aspects of the task of leadership are emphasized (Elmore, 2000; Gronn, 2006; Heller & Firestone, 1995; Kılınç, 2013). It requires a specific period of time and a process for this transformation in leadership understanding to be reflected in school performance and adoption of leadership approaches fitting with the nature of the school's work. On the other hand, the low distributed leadership scores can be associated with school administrators and teachers having little knowledge about distributed leadership.

It was observed that school administrators' and teachers' opinions about a shared school vision were more negative than collaboration and collective responsibility and perceived student achievement. This finding may indicate that the school lacks a vision that is adopted and shared by everyone. Senge et al. (2014, pp. 341-350) posit that a school vision shared by all school staff is important to achieve school objectives and it is the responsibility of all staff to develop this vision. Having a shared and adopted vision is only possible through the active participation of teachers in the vision development process. However, in a study involving primary and secondary schools, Altınkurt and Yılmaz (2011) found that the schools did not have a vision statement. Moreover, even where the schools have vision statements, it may not mean that it is known and adopted by all school staff. The vision development process of schools is carried out within the scope of school strategic planning. Strategic planning in Turkey began in 2003 as a pilot after the "Public Finance Management and Control Law" numbered 5018 was enacted (State Planning Organization [SPO], 2006). With the circulars numbered 2006/55 and 2010/14, MoNE obliged strategic plans for all schools and institutions from 2010. However, the studies revealed a number of problems such as failure to involve all staff in this process, unrealistic targets, failure to associate the plans with the budget, and the lack of belief in planning (Arslan & Küçüker, 2016; Çalık, 2003; Demirkaya, 2007; Memduhoğlu & Uçar, 2012). In a study conducted by Memduhoğlu et al., it was determined that only 35% of teachers were aware of their schools' vision statements (Memduhoğlu et al., 2008 as cited in Memduhoğlu & Uçar, 2012). Doubtlessly, being aware of the vision does not mean that the teachers participated in the vision development process. Therefore, it can be stated that the low mean score obtained from shared school vision is consistent with the literature when considered from a holistic perspective. In research carried out by Gambini (2011), it was

determined that the least practiced dimension of leadership capacity was shared school vision.

In the present study, a significant difference was found between the schools regarding the students' graduation and TEOG scores. It was found that the difference between the graduation scores of the schools was 29% and 22% for TEOG. This finding can be interpreted in two ways. Firstly, the high difference in graduation scores may mean that teachers make more subjective evaluations than common exams administered at the central level. Secondly, it may mean that student-related variables are relatively more determinant than school-related variables in the centralized TEOG exam achievement. This finding is highly important because it is expressed that numerous variables have an impact on student achievement in the central exams such as Student Selection Examination (SSE), Placement Test (PT), and Transition from Primary to Secondary Education Examination (TEOG) (Aslan, 2017; Bahar, 2006; Başol & Zabun, 2014; Berberoğlu & Kalender, 2005; Dinçer, Kolaşin, 2009; Kalaycıoğlu, 2015; Metin, 2013). For example, Aslan (2017) determined that household income, annual expenditure on the child, and parents' educational background predicted 30% of TEOG scores. Therefore, the difference between the explained variance of students' graduation and TEOG scores is consistent with the aforementioned research findings. Moreover, in a meta-analysis conducted by Sarıer (2016) examining 62 studies carried out in Turkey between 2000 and 2015, it was found that the effect sizes of school-based factors, student-based factors, and family-based factors on academic achievement were 0.231, 0.324, and 0.271, respectively.

The lack of a relatively high difference between schools in terms of graduation and TEOG scores might be related to the lower secondary school enrollment system in Turkey which is based on students' addresses and does not take academic achievement into consideration. However, studies reveal that the differences in students' academic achievement are important at schools taking academic achievement into consideration during enrollment. For example, in their study on 2006 PISA results, Dinçer and Koloşin (2009) found that a student studying at a high school that had an enrollment system based on achievement (accepting students based on exam results) obtained a higher score of between 66 and 77 from the PISA compared to other students in Turkey.

In the present research, the predictive power of schools' leadership capacity on students' graduation and TEOG scores was found to be significant. A 1% increase in the school's leadership capacity ratio resulted in an increase of 0.60 for graduation and 3.44 for TEOG. Further, it was determined that school size and location were not significant predictors of graduation and TEOG scores. However, in some studies examining various variables related to academic achievement, there is evidence that school size does affect students' academic achievement (Schreiber, 2002).

The finding regarding leadership is important since it underlines the importance of sharing leadership in the school and emphasizes that all education employees benefit from their expertise skills. Recent studies have focused on the relationship between different leadership approaches and students' learning/academic achievement (Davis, 2009; Gilson, 2008; Heck & Hallinger, 2009; Rivers, 2010). For example, in his dissertation investigating the relationship between distributed leadership and school performance in 34 school districts, Davis (2009) found a positive relationship between distributed leadership scores and students' math achievement. Similarly, Heck and

Hallinger (2009) reported a positive relationship between school leadership and student development. In contrast, in a study involving 396 teachers from 13 elementary schools, Boudreaux (2011) found no relationship between distributed leadership and academic achievement. Hence, evidence on the relationship between various leadership styles and student learning/academic achievement is inconclusive. Moreover, it was observed that empirical studies in national literature focusing this relationship barely exist while the number of studies in international literature is limited compared with other studies on leadership. Therefore, further empirical research is needed to reveal the relationship between leadership approaches at schools and student learning.

The high expectations of schools and school system raise three leadership issues for school. Firstly, the leadership cannot be attributed only to school administrators; instead, the educational process is a collective activity and involving the skills of all educational staff is important for the school organization to achieve its goals. Secondly, school development is a continuous process based on research and data, and the professional development of teachers and administrators is crucial in this process. Thirdly, the functioning and management processes of schools need to be democratized so that all staff can contribute their expertise or skills. These debates show that MoNE should follow the developments in the field of leadership and management and revise the school administration. In this sense, both education faculties and MoNE should organize programs that would develop the leadership skills of administrators and teachers with preservice and in-service training. That is because the variance ratio index explained in this study showed that 62% of the inter-school variance in graduation achievement and 61% of TEOG achievement can be explained by the average leadership capacity of the schools. This finding shows that it is important to improve the leadership capacities of schools both for decreasing the inter-school differences and increasing the academic achievement of students in Turkey.

The literature shows that more empirical research is required to explain the relationship between academic achievement and leadership approaches. Although the current research revealed key findings, it also has some limitations. Firstly, it is a relational study meaning causal comparisons are not possible. For this reason, experimental studies can be conducted to examine the causality between leadership approaches and academic achievement. Moreover, the relations in this study were built at school level and it was not possible to examine relations at the classroom level. Studies, particularly those on teacher leadership, argue that this leadership is performed at the classroom level suggesting that this research could be replicated at this level. The discussion above proposes a range of variables, both in-school and out-of -school are associated with academic achievement. Considering the unexplained variance of academic achievement, future studies can consider different in-and out-of-school variables to explain the differences in student achievement. Additionally, this research was carried out in lower secondary schools, and could be repeated at other levels and in different countries. Thus, research findings from different cultures related to leadership, which is a concept sensitive to cultural differences, can contribute to the enrichment of our understanding of the role of leadership in the development of schools.

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Cumulative disadvantage of college mismatch from college admission to graduation in the United States

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Abstract

Using nationally representative data (Educational Longitudinal Study:02), and a quasi-experimental design, this study examines the causal relationship between college completion and undermatching, when a student attends a less selective college than his/her qualification would permit. This study reveals that undermatching negatively influences college completion within a four year span, and a six year span. In addition, undermatching effects vary widely among students based on college selectivity levels. As the findings of this study reveal, disadvantages related to undermatching continue to grow during college, after the admissions process. These findings highlight the crucial need for further analysis of undermatching, in order to decrease educational inequality and improve college completion rates.

Keywords: College undermatching, academic undermatching, college choice, degree attainment, propensity score matching analysis

Introduction

This study is concerned with the availability of opportunities for college graduation to the undermatched students. Undermatching is not a new concept. It is defined as a student choosing to attend a less selective college than is permitted by his/her qualifications, such as academic credentials, coursework taken in high school, participation in extracurricular activities, and so on. In the past decade, a rich body of research has shown that undermatching is an increasingly common phenomenon that affects a wide variety of students especially underserved population due to lack of information about the admission process, and socioeconomic resources (Belasco & Trivette 2015; Bowen, Chingos, & McPherson, 2009; Lee, Weis, Liu, & Kang, 2017; Roderick, Coca, & Nagoaka, 2008; Rodriguez, 2015; Smith, Pender & Howell, 2013). As a result, scholars have not only asserted undermatching as a potential cause of class-based inequality in higher education, but also identified it as a contributing factor to disparities observed in rates of college completion. As undermatched students attend colleges that have less resources, they may be less likely to graduate college (Hoxby & Avery, 2012; Light & Strayer, 2000).

Although college undermatching is considered to be a problem that needs to be resolved in order to decrease educational inequality and improve college completion rates, the impact of undermatching on college completion is unclear. Some studies (Bowen et al., 2009; Dillon & Smith, 2017; Gansemer-Topf, Downey, & Genschel, 2018; Shamsuddin, 2016) examined the completion gap by college choice. However, none of the studies simultaneously consider the complexity of the admissions process to measure undermatching more accurately, nor do they take into account for selection bias, which is one form of an endogeneity problem which can lead to inappropriate inferences about the effect of undermatching on degree attainment. More importantly, few studies have addressed the complexities of the effect of undermatching for students differing in the kind of college that would constitute a match for them. Given that varied college selectivity are linked to different college quality, and outcome (Shamsuddin, 2016), a careful examination of undermatched students` college graduation and their qualification level can expand perspectives about the effect of undermatching on college completion.

This study fills this gap by using a nationally representative data of college application and admission, and a quasi-experimental design that isolates the causal effect of undermatching on college completion. Further, this study examines the varying impact of undermatching for students` qualification level. These are critical in light of the unreflective assumption that undermatched students are less likely to graduate from an institution than non-undermatched students. The findings from this study will allow a more informed discussion about policy matters related to higher education attainment and undermatching. In addition, this research will provide theoretical insight into the structure of college opportunities, and also deepen our understanding of the link between undermatching and historically underserved populations. Lastly, given that undermatching occurs severely in marginalized students in South Korea (Kang & Youn, 2018), it would raise alarming concerns about the negative effect of undermatching.

Literature review

Combining the information of high school academic records and postsecondary education destination, previous undermatching studies mainly focused on the application and admission process. The studies explore the prevalence of college undermatching in the US at the state level (Bowen et al., 2009; Roderick et al., 2011), and a national level (Belasco & Trivette 2015; Lee et al., 2017; Rodriguez, 2015; Smith et al., 2013), and interventions that could reduce the odds of low-income high-achieving student being undermatched (Hoxby & Avery, 2012). It has been shown conclusively that numerous students in the US chose to enroll in a less selective college than to which they could have gained admission.

Even though there is a consensus that undermatching is prevalent, little attention has been paid to the substantial consequences of undermatching with respect to college graduation. Although not linked to undermatching per se, the literature that has considered the issue of college graduation, in particular the relation between college selectivity and completion, has reported conflicting views on the consequences of undermatching.

Some researchers have implied that an undermatched student could have the advantage of being the "big fish in a small pond." The notion of "big fish in a small pond" is based upon social comparison theory, which posits that self-evaluation is based upon an individual's relative position to his/her peers (Marsh, 2005). Although they focused on high school students, several studies have shown that academically overqualified students in low-ranked schools are likely to perceive themselves as more highly qualified in various academic areas than others, and as a result, they may subsequently outperform their peers (Marsh, 2005). Meanwhile, Bowen and his colleagues (2009) suggested that the positive effect of being the "big fish in a small pond" should be carefully understood, as they showed that higher GPA of undermatched students did not overcome overall negative association between undermatching and college completion.

One the other hand, for a variety of reasons, undermatched students would be less likely to graduate from college than non-undermatched students. Theoretically, Merton's cumulative dis/advantage hypothesis (1973, 1988) shows the way in which college undermatching explains the variation in rates of college completion. The cumulative advantage hypothesis was first proposed by Merton to describe a "Matthew effect," which is a mechanism of allocating social rewards that increases the recognition of established scientists compared to others "who have not yet made their mark" (1973, p. 446). More recently, the concept of cumulative advantage has been invoked to explain other issues of inequality. One key tenet of such studies is that the disadvantage or structural disparities that are incurred initially by individuals lead to even greater disparity over their lifetimes, or as Diprete and Eirich (2006) stated, "The use of cumulative advantage as a description for growing inequality is just another term for describing a pattern of growing inequality" (p. 272). This theory predicts that the initial disadvantage of undermatching will accumulate negatively to affect college experience and college completion.

Apparently, undermatched students are faced with a more disadvantaged climate in the process of college admission than their non-undermatched counterparts. As ample literature has argued, socially disadvantaged students, such as urban, low-SES, and first-generation college students, are more likely to belong to the undermatched group due to lack of information about the admission process, and socioeconomic resources (Bowen et al., 2009; Hoxby & Avery, 2012; Roderick et al., 2011; Rodriguez, 2015; Smith, Pender, &

Howell, 2013). The structural disparities of individual background lead to even greater inequality over the college admission process. Further, as the undermatched student is more likely to face a less positive peer climate and receive less support by their particular institution than the non-undermatched student, they may be less likely to graduate college than their counterparts (Light & Strayer, 2000).

Recent studies mainly support this hypothesis. Using a quasi-experimental design (Dillon & Smith, 2017; Goodman, Hurwitz & Smith, 2015; Shamsuddin, 2016), or a correlation design (Howell & Pender, 2016), previous studies show that college selectivity significantly affects an increase in the likelihood of earning a Bachelor`s degree. Despite its contribution, however, these studies did not reflect the complexity of the admission process, as they focus on the effect of college selectivity which is classified by only SAT, or/and high school GPA. In order to measure undermatching more accurately, a more comprehensive model is required that better reflects the admission procedure, by using not only academic credential but also additional criteria, i.e. math, and science coursework, and participation to extracurricular activities (Bastedo & Flaster, 2014).

Only a few studies have shown that the rate of degree attainment of undermatched students is lower than that of the properly matched with similar academic qualifications (Bowen et al., 2009; Gansemer-Topf, Downey, & Genschel, 2018). For example, Bowen and his colleagues (2009, pp. 106-108) looked at students who had access to the most selective and selective public institutions in North Carolina and showed how those who were undermatched performed in college in comparison to students who were not undermatched. They showed that undermatching was negatively associated with the odds of degree attainment within four years, and six years even after controlling for individual, and high school backgrounds. Consistently, using the Beginning Postsecondary Students, and Educational Longitudinal Study:02 (ELS:02), Gamsemer-Topf and her colleagues (2018) descriptively showed that undermatched students who are interested in obtaining at least a Bachelor`s degree, show lower six-year college completion rate than their counterparts.

Despite its contribution to understanding the consequences of undermatching, previous studies have not examined whether its negative relation vary with the college selectivity in which undermatching occurs. They only focused on the negative relationship between undermatching and college completion for the relatively highly qualified students who would be admitted in a selective college. As Shamsuddin (2016) pointed out, the negative effect of attending less selective college is worse when the college selectivity is lower. It implies that the negative effect of undermatching are not just likely to be found in highly qualified students but in all students, as well as the magnitude of effect of undermatching can vary from the kind of college that constitute a match for them. Thus, it is required to address whether college undermatching effects are consistent across different levels of students` qualification to reflect the college selectivity level where undermatching occurs.

More importantly, as previous findings emerged from a correlational study, their results were obtained without assuring the independence of pretreatment characteristics and treatment group assignment, which limits their ability to claim a causal effect of undermatching on completion. Evidence from previous studies has shown that there are pre-existing differences that might systematically affect both undermatching status and college completion. Undermatching studies have reported that the backgrounds of student and high school (i.e. high school academic achievement, taken coursework, socio-economic background, race/ethnicity, high school mean SES, high school urbanicity, etc.) are strong predictors of the likelihood that a student would be undermatched (Belasco & Trivette,

2015; Bowen et al., 2009; Lee et al., 2017; Roderick et al., 2011; Rodriguez, 2015; Smith et al., 2013). Traditionally, these predictors have been also considered in the models designed to explain variation in degree attainment (Adelman, 2006; Bailey & Dynarsky, 2011; Titus, 2006). These results support the hypothesis that the unbalanced distribution of covariates between undermatched and non-undermatched students could have a systematic influence on college completion. Thus, the confounders that affect undermatching and completion simultaneously should be taken into account in order to derive causal inferences, and obtain unbiased findings (Guo & Fraser, 2014).

Methodology

Data

It contains a nationally-representative sample of students, their families, and high schools from 10th grade through eight years after high school graduation. The target population is students who enrolled in a four-year college within one year of high school graduation. The sample is comprised of 4,970 respondents. The number of observations rounded to the nearest ten for privacy purposes.

Consistent with previous undermatching studies (Belasco & Trivette, 2015; Lee et al., 2017; Rodriguez, 2015; Smith, Pender, & Howell, 2013), Barron's Admission Competiveness Index Data is utilized to classify selectivity of college. Barron's index provides six levels of college selectivity based on the SAT scores of admitted students, the GPA and class rank required for admission, and the percentage of applicants accepted (Barron's Educational Series Inc. 2014). The original Barron's college competitive index categorizes too many college selectivity levels. Previous studies concerned the thinness of data for each selectivity level, and difficulty of acquiring appropriate interpretation. As a result, many studies on college undermatching utilized Barron's index as a criteria of college selectivity, and have re-categorized it into four levels of selectivity; very selective, selective, somewhat selective, and non-selective. Following previous approaches, this study also use Barron's criteria, and re-categorize six categories of Barron's college selectivity index into four categories.

To retain as many cases as possible, multiple imputation by chained equation is employed (Mitra & Reiter, 2012). Unlike single imputation techniques, multiple imputation has advantages to work with over 20 percentage of missing distributions, and it gets an unskewed distribution across imputed datasets distributions (Haji-Maghsoudi et al., 2013; Lee & Carlin, 2012). Before multiple imputation, at the individual and high school level variable, only one undermatching status variable shows over 10 percent of missing (17.16 percent), and others' missing percentage range from a low of .00 to a high of 8.87. After multiple imputation, no case have a remaining missing value (See APPENDIX A for more detail). Due to the use of multiple imputations, all of the models run separately on each of the imputed samples. Analyses are performed on each replaced dataset and then the results are combined across analyses, yielding one final answer. The estimate reports the means from the five separate estimates. The standard errors reported are adjusted to account for the uncertainty of the imputations (Rubin, 2006).

Analytical approach: Propensity score matching technique

To examine the causal effect of undermatching on college graduation, propensity score matching (PSM) is utilized to create comparable samples of high school graduates with undermatched and non-undermatched students. Of course, the most convincing results may come from a randomized experiment, but these are not feasible due to both practical and ethical concerns. For example, it is unethical to assign high school graduates randomly into undermatched and non-undermatched groups. The alternative approach to approximating randomization is the PSM technique. This quasi-experimental design approximates random assignment in order to draw a more causal conclusion of nonequivalent groups by taking into account the confounding factors. Unlike Logistic regression modeling which cannot address the endogeneity issue of treatment variable, the main advantage of using PSM lies in its ability to adjust for confounding factors and accommodate the selection bias that may affect both undermatching and college completion (Guo & Fraser, 2014). If the sample size is too small, the result of PSM can be biased (Iacus, King, & Porro, 2012). Nevertheless, it can be well-acceptable for making causal inference, as this study analyzes a large-scale dataset. Thus, the use of the propensity scores technique, together with a comprehensive dataset based on a large, nationally-representative sample, ELS:02, allows me to draw on the strengths of both experimental and observational designs.

PSM is performed in three steps. As a first step, using the full set of pre-treatment covariates, Logistic regression is conducted to estimate the conditional likelihood of belonging to the "undermatched group" as a function of the observed covariates. Using the estimates, it is generated the predicted probability of each student's undermatching status, given his or her vector of observed covariates, which is the estimated propensity score. In the second stage, utilizing this propensity score, the corresponding sample is created using a one-to-one nearest neighbor matching technique with a caliper of .001 standard deviation. For each student who is undermatched, a corresponding student was selected who is not undermatched and who have an estimated propensity score within .001 of the standard deviation of the given undermatched student's score. Adopting a conservative caliper range, it allows to meet the conditions of PSM more precisely (Lunt, 2013). After creating corresponding samples for undermatched, and non-undermatched students with the propensity score, it is examined whether or not the treatment group and the control group have similar distributions of covariates, in order to check the quality of the PSM. The results of t-test of equality means and standardized differences before and after PSM are reported. The t-test checks for any significant differences in covariates means for both non-undermatched and undermatched students before and after PSM. However, the significant level of t-test is sensitive to sample size. Thus, it is preferable to show the absolute standardized differences, the difference of means or proportions in both groups, divided by a common standard deviation. It is generally proposed that a difference below 10 points for specific covariates indicates the bias is substantially reduced (Stuart, Lee & Leacy, 2013). In the last stage, the use of multivariate logistic regression to controlling for the set of covariates improve the precision of the parameter estimates by accounting for inexact matching. Using only matched samples with propensity score, the Logistic regression models are of the form;

$$Y_i = \beta_0 + \beta_1(C_i) + \beta_2(X_i)$$

where Y_i indicates the log-odds of college completion within four year, or six year relative to "no completion", for student *i*; $Y_i=\log(P_{college\ completion}/P_{non\text{-}college\ completion})$, C_i denotes whether a student is undermatched or non-undermatched, and X_i represents the set of covariates are used in the first stage of the logistic regression. X_i is included to adjust for any residual bias due to the observed covariates that remains because of imperfect matching (Ho, Imai, King & Stuart, 2007). The estimated coefficient β_1 is the average treatment effect of undermatching on college completion Y of child *i*, based on the assumption that the selection of undermatched versus non-undermatched is uncorrelated with the student's potential college completion.

In addition, this study shows the results of separated PSM analysis which reflecting the college selectivity level where undermatching occurs, in order to examine whether the college undermatching effects are consistent in different levels of students` expected college selectivity. The subgroups are defined based on the students` expected college level. This analysis performs three time using three subsamples; (1) students who were expected to be enrolled at a very selective college (*n*=1,230), (2) selective college (*n*=1,980), (3) somewhat selective college (*n*=760). The students, who were expected college level is non-selective (*n*=1,000), are not analyzed as this group does *n*ot have an undermatching case. As the number of subsample is relatively small, a wider caliper of .01 is employed to obtain a comparatively similar matched sample. Following an approach similar to that of Green and Stuart (2014), a same set of covariates is utilized which this study adopt in the total sample analysis because the covariates are independent of treatment conditional on the propensity score in the subgroups.

During the estimation, the case, which is too far beyond the common support area, is not analyzed in order to maximize the quality of PSM (Becker & Ichino, 2002). After PSM, 70 percentage of cases remains in total sample, 51 percentage of cases in the somewhat selective sample, 65 percentage of cases in the selective sample, and 97 percentage of cases in the high selective sample, respectively. Therefore, the results should be carefully understood, because the generalizability to national level is limited to the population of undermatched students with covariates values similar to the non-undermatched students.

Robustness check

Finally, Rosenbaum bounding approach is utilized to examine the sensitivity of the results of my PSM to any hidden bias (Rosenbaum, 2002). The PSM is only able to consider observable covariates in statistical model. Thus, it cannot rule out unobservable factors which may influence both the undermatching status, and the degree attainment, unlike other more robust causal modeling such as difference-in-difference, two stage least squares regression analysis, etc. For example, a very motivated student may match on their choice of college and also be determined to finish quickly. Thus, it is necessary to address the possibility of "what the unmeasured covariates would have to be like to alter the conclusion of the study" (Rosenbaum, 2005; 1809). Rosenbaum's approach states that the identical students with respect to observable covariates have different probabilities of being undermatched in the existence of unobserved variables. It simulates an ascending influence of unobserved factors by using an artificial term Γ, which indicates the odds ratio of the effect of unobservable heterogeneity on the odds of undermatching versus non-undermatching.

Measure

Treatment variable: College undermatching status

Previous undermatching studies proposed several approaches to measure an undermatching. Recently, it is preferable to consider the various factors involved in the college admission process. Thus, this study utilizes approaches that can take into account a variety of factors that can affect the admission process (e.g. Kang & García Torres, 2019; Rodriguez, 2015; Smith et al., 2013), not just those that use SAT and high school GPA grades (e.g. Bowen et al., 2009; Roderick et al., 2011).

To estimate undermatching status, this study first utilized a Probit model to predict the probability of being admitted to college at each level of selectivity using honors-weighted GPA (F1RAGPH); ACT or SAT scores (TXEESATC); the number of AP or IB courses taken (F1RAPIB); the dummy variables of the highest level of math and science course work (F1RMAPIP, F1RSCPIP), whether students participated in intramural or extracurricular activities (F1S26A to F1S26K), how often takes sports lessons outside of schools (F1S39G), and how often takes music, art, or language class outside of schools (F1S39F). The groups analyzed in each model are limited to students who applied at the university level. After that, following previous approaches (Kang & García Torres, 2019; Rodriguez, 2015), it is categorized the student into each of his/her highest expected college levels, using 80 percentage threshold. Of course, this approach does not confirm whether the students are able to recognize the university they applied for has been matched with their conditions. Nevertheless, this approach seems to be useful in revealing whether they have enrolled in a less selective college than they can go to.

Lastly, the students are classified into two groups: undermatched and non-undermatched. When the observed level of college selectivity is below the expected level, the students are classified as undermatched and assigned to the treatment group. The others are classified as non-undermatched and from the control group. In the control group, some of the students can be categorized as "overmatched" which indicates that the expected college level is lower than the actual level. Following previous approaches (Bowen et al. 2009, Kang & García Torres, 2019), however, the overmatched students merged into non-undermatched group with "matched" students. First of all, this classification is beneficial to show the problem of undermatching more clearly. Secondly, and more importantly, previous studies show that the distribution of covariates in these two groups is commonly structured in a way that is different from the distribution of covariates in the undermatched group, and this trend has been identified in the data in this current study as well. 49.77 percentage of students are classified to the undermatching group, and 50.23 percentage of students are classified into non-undermatching group. To be specific, among students who are expected to be admitted to a somewhat selective college, 26.84 percentage students were classified into the undermatched group; 57.53 percentage of students who were expected to enroll a selective college were categorized as the undermatched group; 52.58 percentage of students who were expected to be admitted to a very selective college were classified into the undermatched group.

Dependent variables

To argue not only the main impact of undermatching on graduation likelihood but also

on-time graduation, the two dependent variables are adopted; college completion within four years, and six years after first enrolling in the same four-year college. As it shows whether the student graduated from the institution on time or within the period prescribed by the U.S. federal government, it has an advantage to allow policymakers, higher education associations, and educator to benchmark the result.

Covariates

As argued above in the literature review in this article, previous studies show that there is a series of confounding variables which are simultaneously related to undermatching status, and degree completion. Accordingly, the selection of covariates for this study is mainly guided by the previous studies. At the student level, the models control for student race/ethnicity; gender; income level; whether or not student is a first-generation college student; number of AP/IB courses taken; high school GPA; highest mathematics and science course; participation in extracurricular activities; participation in sport lesson outside of school; participation in music, art, and language classes outside of school; SAT score; base year math score; base year reading score. At the school level, school mean SES, and school mean achievement score, and high school urbanicity and type are utilized (see APPENDIX B for details).

Result

Assessing the PSM quality, and the characteristics of undermatched student

Before estimating the effect of undermatching on college completion using PSM, it is important to assess the quality of such matching by checking whether it reduces the covariates balance between the undermatched and the non-undermatched. Table 1 shows that, with few exceptions, there is evidence of a covariate imbalance between the undermatched and non-undermatched students. There are significant mean differences between the undermatched students and the non-undermatched students of 66.6 percentage (22) of 33 covariates. The overall distribution of covariates between the undermatched and the non-undermatched students is consistent with the results of previous studies that analyzed factors predicting undermatching status (Belasco & Trivette, 2015; Lee et al., 2017; Rodriguez, 2015; Smith, Pender, & Howell, 2013). The historically underserved population, low SES, first-college generation, and rural locations are more likely to be undermatched, since the highly qualified students with greater academic achievement, and a rigorous coursework record, were less likely to be undermatched.

Furthermore, before PSM, fourteen of the covariates show standardized difference scores above 10, indicating an imbalanced distribution of covariates between the undermatched and the non-undermatched groups (Stuart et al., 2013). In particular, five covariates, i.e., family income level over $100,000, first college generation, high school mean SES, high school GPA, and suburban private high school, show extremely high values of standardized difference, as they are over 20. This result indicates that the full sample had an imbalanced distribution of covariates between the non-undermatched and the undermatched

Table 1. Differences in mean and absolute standardized difference before and after PSM

	Before Matching				After Matching			
	Mean		D	ASD	Mean		D	ASD
	U	NU			U	NU		
Gender (reference = female)	0.43	0.47	-0.04*	8.00	0.43	0.43	0.00	0.12
Race (reference = White)								
Hispanic	0.06	0.08	-0.02*	7.04	0.06	0.06	0.00	1.78
Black	0.08	0.11	-0.02*	7.62	0.09	0.09	0.00	0.48
Asian	0.12	0.17	-0.05***	14.66	0.12	0.12	0.00	0.88
American Indian	0.00	0.00	0.00	1.18	0.00	0.00	0.00	0.62
Income level (reference=0-25000$)								
25000-50000	0.24	0.20	0.04**	9.60	0.23	0.23	0.01	1.76
50000-75000	0.24	0.20	0.05**	10.90	0.24	0.24	0.00	0.98
75000-10000	0.20	0.18	0.02+	5.96	0.20	0.21	-0.01	1.48
100000$ over	0.22	0.33	-0.11***	25.56	0.22	0.22	0.00	0.08
First college generation (reference = no)	0.41	0.30	0.11***	23.70	0.40	0.40	0.00	0.08
First language as English (reference = no)	0.90	0.84	0.06***	16.58	0.89	0.89	0.00	0.82
Educational expectation (reference = graduate college)								
Enter a college or below	0.01	0.01	0.00	3.86	0.01	0.01	0.00	0.76
Beyond college completion	0.60	0.67	-0.07***	15.14	0.61	0.61	0.00	0.64
Math highest level coursework (reference = basic)	0.32	0.34	-0.02	3.86	0.32	0.32	0.00	0.08
Mid								
High	0.65	0.64	0.02	3.24	0.65	0.65	0.00	0.14
Science highest level coursework (reference = basic)	0.30	0.28	0.02	4.26	0.29	0.30	0.00	1.06
Mid	0.62	0.63	-0.01	1.80	0.63	0.62	0.00	0.78
High	1099.22	1109.68	-10.46+	5.92	1099.90	1099.72	0.18	0.12
SAT score	3.46	3.32	0.14***	24.30	3.45	3.45	0.00	0.54
High school GPA	1.55	1.79	-0.24***	11.22	1.57	1.57	-0.01	0.30
Number of AP coursework	57.97	57.93	0.05	0.60	57.96	58.15	-0.18	2.38
Base year Math score	57.45	57.19	0.25	3.18	57.46	57.46	0.00	0.02
Base year Reading score	0.85	0.89	-0.04***	12.22	0.86	0.86	0.00	0.54
Participation in Extracurricular activities	1.41	1.49	-0.07**	8.30	1.41	1.43	-0.02	2.30
Participation in out of school sport lesson	1.62	1.66	-0.04	3.92	1.63	1.64	-0.02	1.48
Participation in out of school music, art or language lesson	57.00	57.37	-0.37*	7.54	57.01	57.09	-0.08	1.54
School mean achievement	0.39	0.52	-0.13***	31.62	0.40	0.40	0.00	0.56
School mean SES	0.14	0.15	0.00	1.02	0.15	0.15	-0.01	1.54
High school setting (reference = Urban public)								
Urban private	0.32	0.31	0.01	2.82	0.32	0.32	0.00	0.74
Suburban public	0.15	0.24	-0.09***	22.28	0.16	0.15	0.01	1.66
Suburban private	0.16	0.11	0.06***	16.82	0.16	0.16	-0.01	2.50
Rural	57.83	58.05	-0.22	2.84	57.85	58.03	-0.19	2.38

Note. U=Undermatching; NU=Non-Undermatching; D=Mean Difference; ASD = Absolute Standardized Difference. $^{\dagger}p < .10$; $*p < .05$; $**p <. 01$; $***p < .001$.

students, and it is necessary to take into account the selection bias for the validity of a causal inference.

After PSM, there are no significant differences between the undermatched students and the non-undermatched students on measures of all covariates ($p > .05$). Furthermore, all thecovariates have absolute standardized differences that did not exceed 5. It ranges from a low of .44 to a high of 2.50. Thus, as observed, systematic differences between undermatched students and non-undermatched students appear to have been greatly reduced, and it indicates that the PSM adopted achieves balance on the covariates.

Undermatching effect on college completion

Using the PSM technique, this study examines the effects of college undermatching on college completion within four and six years. Table 2 shows that the results predicting the likelihood of degree attainment within four and six years in a full analytic sample, in which regressed the odds of college graduation on undermatching and covariates after matching the sample with a propensity score. After adjustment for confounding variables, the results reveal that undermatching has a negative effect on completion within four and six years. Undermatched students show significantly 22 percent lower odds to graduate college within four years, and 23 percent lower odds to graduate within six years than non-undermatched students.

Table 2. Results predicting college completion within four year and six year in full sample

Outcome	Propensity score matched sample[a]		
	Coefficient	Standard error	Odd ratio
College completion within 4 year	-.25*	.08	.78
College completion within 6 year	-.26**	.07	.77

[a] logistic regression of college undermatching on outcome and covariates within sample matched by propensity score.

Note: All of covariates, including student and school characteristics, are adjusted. Total sample size is 4,970. Clustered robust standard errors are reported. *$p < .05$; **$p < .01$

See Figure 1 for the visual representation of this finding. It graphically demonstrates the predicted probability of college completion within four and six years as a function of undermatching, holding constant with covariates. This graph shows the adjusted probability of degree attainment within four years and six years for the non-undermatched and the undermatched groups, assuming each covariate has a mean value of each. The probabilities to graduate college within four years and six years were adjusted only within samples matched by propensity score. The graph presents that the predicted ratios of degree attainment within four years were approximately 43 percent for the non-undermatched group and 37 percent for the undermatched group, respectively. The estimated ratios of college completion within six years were approximately 75 percent for the non-undermatched and 71 percent for the undermatched, respectively. This shows that undermatched students less likely to graduate from college within four years, and six years than their counterparts.

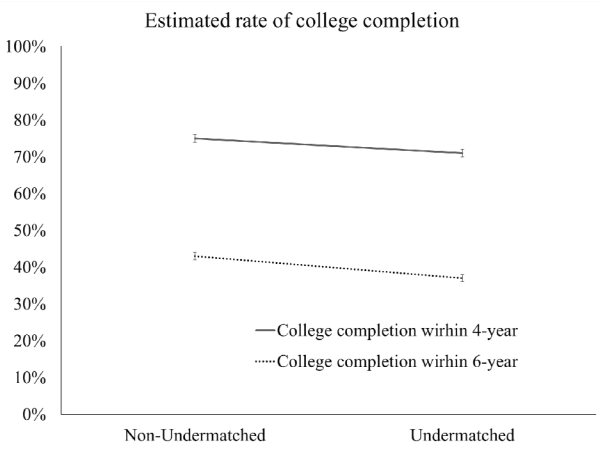

Figure 1. Predicted probabilities of college completion within four years and six years as a function of undermatching

Note. All covariates are fixed at their mean. Only matched sample with propensity score was analyzed. The error bars indicate 95 percent confidence interval.

Further, to assess whether the undermatching effects were consistent, a subgroup analysis according to students' expected college selectivity level is conducted. Because this study utilizes PSM discretely which reflected the college selectivity level where undermatching occurs, it is necessary to check the quality of PSM separately for each subgroup analysis. After matching using the estimated propensity score for each subgroup, the standardized differences of covariates were all below 10 points indicating that the imbalanced distribution of covariates was largely reduced.

Table 3. Results predicting college completion within four year and six year across expected college selectivity

Expected college selectivity	Outcome: College completion	Propensity score matched sample[a]		
		Coefficient	Standard error	Odd ratio
Somewhat (*N*=760)	within 4 year	-.08	.29	.92
	within 6 year	-.52*	.23	.59
Selective (*N*=1,980)	within 4 year	-.38**	.13	.68
	within 6 year	-.26†	.13	.77
Very selective (*N*=1,230)	within 4 year	-.29†	.17	.75
	within 6 year	.13	.21	1.14

[a] logistic regression of college undermatching on outcome and covariates within sample matched by propensity score.

Note. All of covariates, including student and school characteristics, are adjusted. Clustered robust standard errors are reported. $^{\dagger}p < .10$; $*p < .05$; $**p < .01$

Finally, Table 3 shows the results predicting college completion within four years and six years across expected college selectivity. Results show different tendencies of undermatching effects dependent upon students' expected college selectivity level and how long students take to graduate college. For those who were expected to enroll in a

somewhat selective college, there is a negative effect of undermatching on completion within six years, but not four years. For them, there is no evidence that undermatched students had less likelihood of getting a college degree within four years than their counterparts. Meanwhile, among those students, the odds of degree attainment within six years decreased 41 percent when they are undermatched.

The results for those students who are expected to access a selective college or a very selective college are different. First, for those who are expected to enroll in a selective college, undermatching negatively influences graduation within four years and six years. Among this group, the undermatched students show significantly 32 percent lower odds to graduate college within four years, and 23 percent lower odds to get a college degree within six years than non-undermatched students, nearing significance.

Second, for those who are expected to access a very selective college, the evidence shows that there is a negative effect of undermatching on completion within four years, but not within six years. Among this group, when they are undermatched, the odds to graduate college within four years decreases 25 percent, nearing significance ($p < .10$). However, for them, there is no significant difference in the likelihood of college completion within six years between the undermatched and non-undermatched groups.

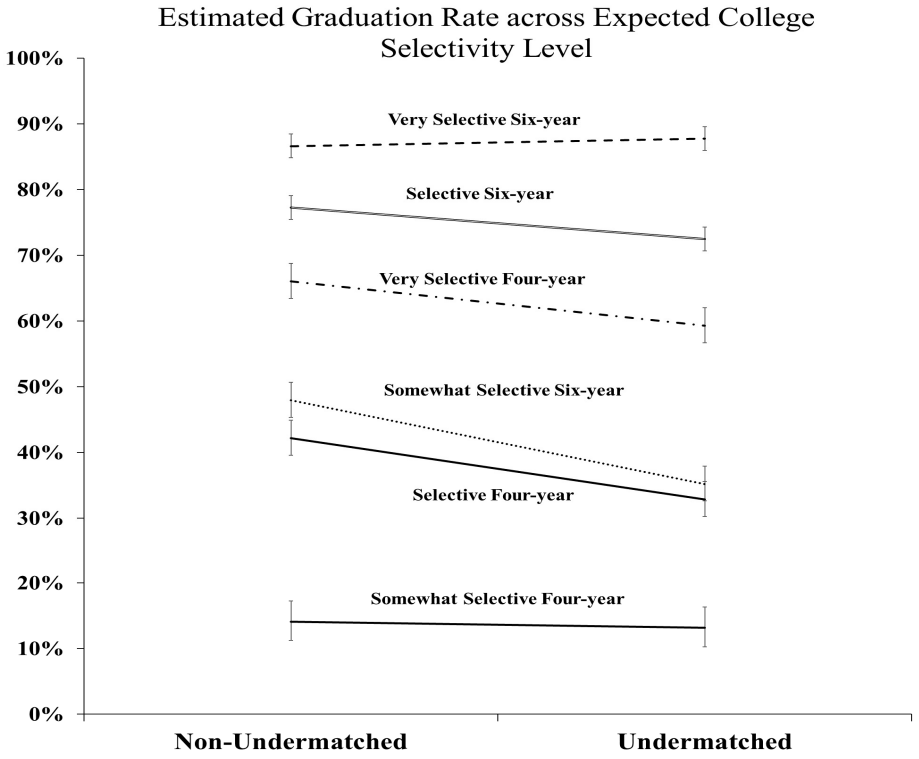

Figure 2. Predicted probabilities of college completion within four years and six years as a function of undermatching by students' expected college selectivity lLevel

Note. All covariates are fixed at their mean. Only matched sample with propensity score was analyzed. The error bars indicate 95 percent confidence interval.

Figure 2 graphically represents the predicted probabilities of college completion within four and six years as a function of undermatching across three students' expected college selectivity level. For students who were expected to enroll in a somewhat selective college, the predicted ratios of college completion within four years were 14.10 percentage point for non-undermatched, and 13.15 percentage point for undermatched group, respectively. Meanwhile, for students expected to enroll a very selective college, the predicted ratios of college completion within six years were very high over all, as the non-undermatched and undermatched group showed 86.61 percentage point, and 87.73 percentage point adjusted ratio of degree attainment within six years, respectively. For these cases, the 95 percent confidence intervals of values potentially indicate the difference between the groups were not significant.

Except these two cases, rest lines potentially showed the significant or almost significant difference of likelihood of college completion between non-undermatched and undermatched groups. First, for students expected to enroll a somewhat selective college, the predicted ratio of college completion within six years were 47.94 percentage point for non-undermatched, and 35.22 percentage point for undermatched group, respectively. Second, for students who were expected to enroll a selective college, the predicted ratio of college completion within four years, and six years were 42.17 percentage point, and 77.24 percentage point for non-undermatched, and 32.88 percentage point, and 72.46 percentage point for undermatched group, respectively. Finally, for students who were expected to enroll a very selective college, the predicted college completion within six years rates were 77.24 percentage point for non-undermatched students, and 72.46 percentage point for undermatched students, respectively.

Sensitivity analysis

Table 4 shows the results of the Rosenbaum bounding approach. As PSM is only able to consider observable confounders, thus it is necessary to check the robustness of my findings to any unobservable bias. As the key concern is overestimation of the undermatching effect, I did a sensitivity analysis of the cases to show the significant effect of undermatching on completion in my previous analysis. The significant level p indicates the bound on the significance level of the undermatching effect at a certain Γ value. As described in the methodology, Γ indicates to the odds ratio of the effect of unobserved confounders on the odds of undermatching versus non-undermatching. In other words, when $\Gamma = 1$, there are no hidden biases, and at $\Gamma = 1.1$, it assumes that a positive selection bias would increase the odds of undermatching for the undermatched student by 10 percent relative to the non-undermatched students. The results show that at all ranges of Γ from 1.0 to 2.0, the significant effect of undermatching is consistently found. It indicates that the unobserved heterogeneity does not change the effects of undermatching under such scenarios.

Table 4. Rosenbaum Bounds, Effect of Undermatching

	Total sample				Subgroup							
	College completion within 4-years		College completion within 6-years		Somewhat selective college completion within 6-years		Selective college completion within 4-years		Selective college completion within 6-years		Highly Selective college completion within 4-years	
Γ	Q^+	*p*	Q^+	*p*	Q^+	*p*	Q^+	*p*	Q^+	*p*	Q^+	*p*
1.0	3.42	.00	2.53	.01	1.92	.03	3.03	.00	1.64	.06	1.69	.05
1.2	6.01	.00	4.94	.00	2.76	.00	4.68	.00	3.16	.00	2.90	.00
1.4	8.16	.00	7.05	.00	3.45	.00	5.84	.00	4.25	.00	3.94	.00
1.6	1.11	.00	8.77	.00	4.11	.00	7.14	.00	5.35	.00	4.86	.00
1.8	11.84	.00	1.38	.00	4.59	.00	8.15	.00	6.35	.00	5.54	.00
2.0	13.36	.00	11.68	.00	5.13	.00	9.15	.00	7.21	.00	6.25	.00

Note. Γ refers to the odds ratio of the effect of unobserved confounders on the odds of undermatching versus non-undermatching. Q^+ indicates that the simulated test-statistic under the assumption that the undermatching effect is overestimated.

Discussion

This study found that undermatching has a negative effect on degree attainment. After controlling for selection bias, the results reveal that the undermatched students were less likely to graduate within four years, and six years, than their counterparts. The salient findings of this study confirm the notion of Merton's cumulative disadvantage hypothesis (1973, 1988), also known as the "Matthew effect", which posits that initial structural inequality leads to even greater inequality over the course of the lifespan. Socially disadvantaged students, defined as, for example, low-SES, minority, first college generation, and urban/rural students, are more likely to belong to the undermatched group due to lack of information about the admission process, socioeconomic resources, and social network (Bowen et al., 2009; Hoxby & Avery, 2012; Roderick et al., 2011; Rodriguez, 2015; Smith, Pender, & Howell, 2013). The admission process is "the accumulation of advantages and disadvantages over the course of the first 18 years of life that leads to massive preparation differences by the time of college application" (Bowen, Kurzweil, & Tobin, 2005, 255). After the admission process, disadvantages related to undermatching can continue to grow while in college. As the findings of this study revealed, the experience of undermatching carries over into inequality in college graduation. Furthermore, this inequality in degree attainment can extend to post higher education, labor market outcomes and beyond, since college selectivity and degree completion are strongly correlated with future wages (Dale & Krueger, 2011; Long, 2008).

The results suggest that college guidance services, which provide information on college admission and financial aid planning, is important to all students to find and apply to a "matched" college based on their qualifications. Historically, the US federal and state

governments have attempted to close the gap in postsecondary educational attainment by focusing their efforts on providing financial aid (Schneider, 2010). Although governmental financial support sounds promising, the influence of undermatching upon college completion must also be taken into account, as low graduation rates may be incurred due to the entrance process, not simply financial deficits (Dillon & Smith, 2017). Several interventions showed promising outcomes to reduce undermatching rates for high or moderate achieving, low-income students (Hoxby & Turner, 2013). When such students received enough personalized information about colleges and fee waivers to apply to their matched college, those students were more likely to apply to, and enroll in a matched college than their counterparts. A recent study also shows that interventions would also be valid for less academically inclined, or modest, students (Belasco & Trivette, 2015). Therefore, an information intervention that would help to prevent undermatching is fundamentally required for all students to minimize the negative effects of undermatching.

In addition, this study contributes by assessing the influence of undermatching for the students differing in the kind of college that would constitute a match for them. Overall, the findings of this study show that undermatching negatively influences college completion within four years, and six years. However, the students' expected college selectivity level added a layer of complexity to the negative effect of undermatching. Among those students who were expected to enroll in a somewhat selective college, undermatched students have less likelihood of getting a college degree within six years, but not within four years. Interestingly, the negative effect of undermatching on completion within six years for this group is the strongest across all subgroup analysis. This implies that students who were undermatched somewhere between a somewhat selective college and a less selective college might be most disadvantaged by undermatching in attaining college degree within six years. Thus, it is required to extend a support beyond the traditional approach of focusing on highly qualified students to reduce the negative effects of undermatching (Gansemer-Topf et al., 2018; Hoxby & Avery, 2012), and to students with relatively lower academic performance. In contrast, in the case of the students who were highly qualified and expected to enroll in a very selective college, there was only a negative effect of undermatching on completion within four years. It suggests that the colleges need to encourage the undermatched and highly qualified students to attend the institution persistently to recoup the loss from undermatching.

One important question which is still unresolved is the way in which undermatched students show lower graduation rate than their counterpart. This is important because it could provide empirical evidence for policy discussion which is related to improving attainment in higher education and insight into how colleges alleviate the problem of improper college choice and access. Several previous studies show that those students, who are attending a less selective college are more likely to enroll in an institution which has a less positive peer climate (Titus, 2004). It indicates that the non-undermatched student who attends a more selective institution could get benefit from a peer group which has a stronger normative climate in pursing college completion. In addition, several studies suggested that undermatched students could be disadvantaged in terms of college completion because they receive less student service from the comparatively less selective college (Webber, 2012; Webber & Ehrenberg, 2010). Not only do highly selective colleges, on average, have more financial resources for student services than less selective colleges, but also there is a positive relation between student services expenditure and college completion rate within six years. Given that empirical evidence of these studies, it is

reasonable to hypothesize that the lower expenditure of student services affects undermatched students. More sophisticated analysis, such as multiple-mediation analysis should be further required to verify such hypotheses.

Furthermore, future research can contribute to a more extensive understanding on the effects of undermatching by building on these results and overcoming the limitations of this study. The analysis of the undermatching effect should be extended to include a larger target population, and the diverse aspect of undermatching effects. This study focused only on college completion among four-year college students in the United States. As a result, it neither covers the students in other countries, the issue of two-year college and non-college students, nor transfer students. Thus, this study is limited to the students who were already on a more academic trajectory in one country. Undermatching studies have shown approximately 40 percent of students attending two-year colleges, or non-college going students were undermatched in the United States (Rodriguez, 2015; Smith et al., 2013), and around 50 percent of Korean students were undermatched (Kang & Youn, 2018). Future studies should be conducted with broader samples including other countries, and/or two-year and non-college students in order to improve our understanding about the effect of undermatching on college attainment.

In addition, a more refined method to estimate the prevalence of undermatching is essential. While the ELS:02 data includes abundant information about quantified measures of student qualifications, such as academic achievement scores, academic coursework, extracurricular activities, etc., it does not include detailed information on certain critical application components (e.g. quality of essays, or letters of recommendation). By using only quantitative indicators to estimate the undermatching status, it was not possible to reflect the complexity of admissions processes of highly competitive colleges (Bastedo & Flaster, 2014). Therefore, more and varied measures of both quantitative and qualitative data—e.g., through open-ended interviews with students about admission processes—would allow us to predict more accurately who would be admitted to colleges of varying selectivity. This more comprehensive approach will also provide more accurate estimation of the effect of undermatching on higher education attainment.

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APPENDIX A. Missing distribution

	Missing	Total case	Percent missing
College completion within four year	410	4,800	8.5
College completion within six year	410	4,800	8.5
Undermatching status	820	4,800	17.2
Race/Ethnicity	210	4,800	4.3
High school GPA	330	4,800	7.0
Number of AP coursework	330	4,800	6.9
Participation in Extracurricular activities	30	4,800	0.7
Participation in out of school sport lesson	150	4,800	3.1
Participation in out of school music, art or language lesson	150	4,800	3.1
SAT	430	4,800	8.9
Math highest level coursework	330	4,800	6.9
Science highest level coursework	330	4,800	6.9
Base year Math score	40	4,800	0.8
Base year Reading score	40	4,800	0.8
High school mean SES	10	4,800	0.3

Note. Gender, income level, first college generation, first language as English, high school mean achievement, high school setting variables does not have missing case, and omitted to report. Observations rounded to the nearest ten according to NCES`s regulation. Figures are weighed using F3BYTSCPSWT.

APPENDIX B. Variable List and Descriptive Statistics

Variable name	Description	*Mean*	*S.D*
Dependent variable			
Within 4 year college completion	A dummy variable coded 1 if a student graduate college within a forty-eight months after college entry (*F3PS2BA*)	.43	.49
Within 6 year college completion	A dummy variable coded 1 if a student graduate college within seventy-two months after college entry (*F3PS2BA*)	.71	.45
Treatment variable			
Undermatching status	A dummy variable coded 1 if a student is undermatched. (See analytic approach section for detail)	.46	.50
Pre-treatment covariate			
Student factor			
Gender	A dummy variable coded 1 if student is female. (*F1SEX*)	.46	.50
Race/Ethnicity	Set of 5 dummy variables whether a student's race is White (reference group), Black, Hispanic, Asian, or American Indian. (*F1RACE2*)	Hispanic : .14 Black : .08 Asian : .10	.35 .26 .30
First-college generation	A dummy variable coded 1 if student's parent is not graduated college. (*F1PARED*)	.37	.48
Native language is English	A dummy variable coded 1 if the first language student learned to speak when he/she were a child (*F1STLANG*)	.86	.34
Income Level	Set of 5 dummy variables of family income reported by parent; $0–$25,000 (reference group), $25,001–$50,000, $50,001–$75,000, $75,001–$100,000, over $100,000. (*BYINCOME*)	25k$-50k$: .23 50k$-75k$: .22 75k$-100k$: .18 100k$ over : .27	.42 .41 .39 .44
Educational expectation	Set of 3 dummy variables whether student's educational expectation is completing college (reference group), entering a college or bellow (EC), or beyond a college completion (BC) (*F1S42*)	EC: .02 BC: .62	.14 .48
Science taken coursework	Set of 3 dummy variables whether student's taken highest level of science coursework is basic level coursework (no science, Primary Physical science, Secondary physical science and basic Biology, General biology), medium level course work (Chemistry 1 or physics 1), or high level course work (Chemistry 1 and physics 1, Chemistry 2 or Physics 2 or Advanced biology, Chemistry and Physic). The reference group is those who took basic coursework. (*F1RSCPIP*).	Mid : .30 High : .60	.46 .49
Math taken coursework	Set of 3 dummy variables whether students taken highest level of math coursework is basic course work (No math, Non-academic, Low academic, Middle academic), middle level coursework (Middle academic II, Advanced I), or high level coursework (Advanced	Mid : .35 High : .62	.48 .49

Variable name	Description	*Mean*	*S.D*
	II/Pre-calculus, Advanced III/Calculus). The reference group is those who took basic coursework. (*F1RMAPIP*).		
High School GPA	Numerical variable; honors weighted G.P.A (*F1RAGPH*)	3.33	.62
Number of AP or IB course	Numerical variable; the number of Advanced Placement or International Baccalaureate courses reported on students' transcripts, in Carnegie units, over the course of high school (*F1RAPIB*)	1.59	2.11
Participation in extracurricular activity	A dummy variable coded 1 if student have participated in at least one extracurricular activity. This variable is derived from the question, "Have you participated in the following school-sponsored activities this school year?" 0 = "did not participate;" 1 = "participated" or "participated as an officer, leader, or captain" for sports (*F1S26A, F1S26B*); performing arts (*F1S26C, F1S26D*); student government, honors society and yearbook (*F1S26E, F1S26F, F1S26G*); community service (*F1S26H*); academic clubs (*F1S26I*); hobby (*F1S26J*); vocational clubs (*F1S26K*)	.85	.36
SAT score	Numerical variable; students' SAT score. The score of American College Testing (ACT) is translated to SAT score by NCES. (*TXEESATC*)		
Base year reading score	Numerical variable; students' base year students' reading score, which is derived by NCES. (*BYTXRSTD*)	57.49	7.98
Base year math score	Numerical variable; students' base year students' math score, which is derived by NCES. (*BYTXMSTD*)	56.94	8.16
Participation in sports lessons outside of school	Numerical variable; this variable is derived from the question how often takes sports lessons outside of school 1 = "rarely or never;" 2 = "less than once a week;" 3 = "once or twice a week;" 4 = "every day or almost every day" (*F1S39G*)	1.45	.90
Participation in music, art, language class outside of school	Numerical variable; this variable is derived from the question how often takes music, art, language class outside of school 1 = "rarely or never;" 2 = "less than once a week;" 3 = "once or twice a week;" 4 = "every day or almost every day" (*F1S39F*)	1.63	1.04
High school factor			
School men SES	Numerical variable; School mean value of standardized score of socio-economic status composite variable (*F1SES2, SCH_ID*)	112.00	10.48
School mean academic achievement	Numerical variable; School mean value of students' test composite score of math and reading score (*BYTXMSTD, BYTXRSTD, SCH_ID*)	.44	.43
High school setting	Subgroup categories; public urban (reference group), public suburban (PrS), private urban (PrU), private suburban (PS), rural (R) (*F1RSLURB, F1RSLCTR*)	PrU : .14 PrS : .31 PS : .19 R : .13	.35 .46 .39 34

Note. The italics indicate the original variables in ELS:02.

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Urban zoning and inequality in access to literacy: A case study of Kazakhstan

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Abstract

The aim of the article is to find out the presence vs. absence of influence of the location and types (private and state) of secondary schools on reading literacy in Kazakh, Russian and English. Statistical analysis of 297 questionnaires of ninth grade students of the state and private schools of Almaty city was done. Four parameters of variable correlations were used: Pearson linear correlation coefficient (chi-square); *p*-level; comparison of the expected and obtained results, and median of levels of reading literacy in Kazakh, Russian and English. The research identified complex and coherent mutual relationships between social and economic inequality, and reading literacy. Social and economic inequality made a current and prolonged influence on the condition of the educational process.

Keywords: Reading Literacy, Urban Zoning, Kazakh, Russian, English

Introduction

Kazakhstan is one of the countries participating in the international monitoring of the quality of national education in respect to reading literacy as conducted by PISA (Thomson, Hillman & Bortoli, 2013). Upgrading Kazakhstan's educational system takes place in the context of the positive global trends related to changes of strategic goals, which prioritize at creating conditions for successful adaptation of the younger generation to the changing conditions of social and economic life. The objectives and the purpose of improving functional literacy are reflected in the Law of the Republic of Kazakhstan "On Education" dated 05.05.2017, "State Program of Development of Education of the Republic of Kazakhstan for 2011-2020" Decree of the President of the Republic of Kazakhstan #1118 dated 7.12.2010, "National Action Plan for the Development of Functional Literacy of Students for 2012-2016" Decree of the Government #832 dated 25.06.2012, as well as UNESCO's recommendations on continuing education.

However, the existence of a legal framework, a variety of programs that change the strategic objectives and priority aiming at the students' successful adaptation to the conditions of social and economic life, still does not provide the solution to problems related to reading literacy. There is a need for thorough monitoring and analysis of cultural and linguistic diversity and the existing exceptions in education, connected with social and other differences.

This article aims to discuss the results of a sociolinguistic research. The purpose of the article is to identify the presence vs. the lack of correlation of reading literacy in the Kazakh, Russian and English languages as regards the location and type (private and public) of school. Respondents were ninth grade students of public and private secondary schools of Almaty city, Kazakhstan.

The focus of this research is to determine the relationship between junior high school senior-students' reading literacy in Kazakh, Russian and English languages with the type of school (private or public) and its location.

Materials and methods

A detailed questionnaire was developed and distributed among graduating students of the lower secondary schools. The questionnaire was based on the work of others who had previously examined language policy in Kazakhstan (Rivers, 2003; Robinson, Andreyenkov, & Patrushev, 1988; Suleimenova, Shaimerdenova, & Smagulova, 2005) and the Soviet Union, as well as studies investigating reading literacy (Sabatini & Bruce, 2011; Kovaleva, Krasnovskyi, Krasnokutskaya, & Krasnyanskaya, 2003).

The questionnaire was modified and supplemented in order to obtain accurate data on the level of the respondents' reading literacy in the Kazakh, Russian and English languages, and on the socio-economic status of respondents, assigned by parents.

The questionnaire consists of two parts: The first part contains 45 questions, 10 of which are open-ended questions, 17 are multiple-choice and 18 are semi-closed questions; the second part of the questionnaire is in the form of questions on texts for assessing the reading literacy of respondents in Kazakh, Russian, and English. Nominal data measurement scale is applied in designing the questionnaire, which sub-categorizes different types of data

and labels variables, without any quantitative value.

The first part of the questionnaire is designed to determine the socio-economic status of the respondents and the functioning of languages in this group, namely among ninth-grade students of secondary public and private schools in the city of Almaty.

The survey was anonymous and was carried out after obtaining verbal permission from the school administration (principal or head teacher) in the presence of the class teachers or subject teachers. The presence of a school employee during the administration of the questionnaires was a deliberate action, as the authoritarian character of the employee had a "positive" effect on the response rate of the respondents. The survey took 45 minutes and was conducted after instructions were given on how to fill out the questionnaire. Three questionnaires were deemed unsuitable for technical reasons, 297 questionnaires were processed and analyzed using SPSS V19.

The questionnaires were distributed as follows: 100 (33.7%) questionnaires to central state schools students, 123 (41.4%) questionnaires to state schools students situated in the lower suburb of Almaty, and 74 (25%) questionnaires to private schools students.

The representativeness of the sample and the balance was justified as follows:

a) Almaty is the financial, cultural and information center of the country, an urbanized model of social stratification and socio-economic zoning. The principle of selection of the city comes from the theory of socio-economic zoning of an urbanized city, which assumes that the area of large industrial cities is heterogeneous in terms of socio-economic situation (Gorkin, 2013). So in sociology, often not only the social but also the physical (geographical) area of the city is stratified ("prestigious", "not prestigious", "problem" areas) (Giddens, 1989). "Prestigiousness" of an area stands out with its trappings: the protection of residential areas, cleaned up flowerbeds or buildings with playgrounds. From this point of view, the former capital, the former regional center and the largest metropolis of the country, Almaty city, which is de facto a financial, cultural and information center of the country, represents an ideal example of social zoning. Thus, the central and the "top" ("foothill") districts of Almaty are considered to be prestigious, while the "lower" parts are less prestigious (Azhenov & Beisenbayev, 1997).

b) The respondents are 15-year-old ninth grade students of state and private schools in the city of Almaty. By this age a mandatory training in the basic foundations of the system of sciences, the formation of the high culture of interpersonal and interethnic communication, self-identity and professional orientation, had been completed (The Law of the Republic of Kazakhstan "On Education", 2017). At this stage of education it is important to determine the status of the knowledge and skills that can be useful to students in the future, as well as to evaluate the students' ability to independently acquire knowledge necessary for successful adaptation to the contemporary world.

c) For the survey, seven secondary public and private schools in the city of Almaty were selected: two were state schools located in the center, two were state schools located on the bottom edge of the city and three were private schools. All schools offer educational courses in several languages. It is worth noting that Kazakhstan has created a system of state support of languages of ethnic groups living in Kazakhstan, which allows obtaining the basic secondary education, by choice, in the state language (Kazakh), Russian or in the languages of ethnic groups. Along with schools that use the languages of Uzbek (58 schools), Uighur (14 schools), and Tajik (2 schools) as languages of instruction, there are schools of a mixed variety, which have classes with different languages of instruction, for example, state (Kazakh) / Russian, state (Kazakh) / ethnic or Russian / ethnic. In addition,

private schools offer education for all or some of the school subjects of choice in English, so there were schools with state (Kazakh) / English and Russian / English languages of instruction. As such, 2097 secondary schools out of 7516 in Kazakhstan are mixed. But, regardless of the language of instruction, all students of Kazakh schools learn Kazakh and Russian languages from the first grade, and English was taught from the fifth grade. From September 2013, English started to be taught from the first grade of all public basic secondary schools of Kazakhstan (The Government of the republic of Kazakhstan, 2012).

d) The next criterion for selecting schools for the study is ownership. State secondary schools are financed from the national budget, and private educational institutions are financed by tuition. Regardless of the type, (private or state) all public schools must comply with the basic constitutional and educational standards of the Republic of Kazakhstan, such as mandatory (from primary education to the end of secondary education), duration (primary education is 4 years, the basic secondary education is 5 years, the general secondary is 2 years, for a total of 11 years) and continuity (three educational stages of education: primary, basic secondary, general secondary education) of secondary education (The Law of the Republic of Kazakhstan "On Education" dated 05.05.2017). The above-mentioned characteristics of schools are of key importance for this research: a greater coverage of the respondents belonging to different social strata and with different language and reading habits were achieved.

The sampling included 4 schools (2%) of the 195 public schools, boarding schools, vocational schools and high schools, as well as 3 schools (6.9%) of the 43 non-public schools in the city. The main reason for considering schools in the context of public / private, central / non-central is the principle of dividing the city into regions depending on the socio-economic status of the population of these regions. To ensure representativeness on the grounds of social zoning, two central public schools, two public schools situated in the lower suburb of the city, and three private schools, located in the center or on the upper edge of the city were selected. A larger number of private schools participated in the survey (3 vs. 2 + 2). This is explained by the fact, that the number of students in these schools is noticeably lower than in public schools. To ensure the proportionality of the respondents the number of private schools participating in the study was increased.

The dependent variables were the levels of reading literacy in the Kazakh/Russian/English languages as defined by the CEFR (Common European Framework of References for Languages, 1971). The following independent variables were examined as predictors of the dependent variables: the socio-economic status of the respondents assigned by parents, determined by location and types (private and state) of schools, education level, income, economic activity of parents of respondents, the indicators of cultural capital (reading habits, the number of books in home library), the frequency of the respondents' travelling to the countries of the CIS (Commonwealth of Independent Countries) and others. In total 75 correlations have been analyzed.

To investigate the relationships between variables, four parameters were used to measure nominal data obtained as the result of the questionnaire: 1) a linear correlation coefficient of Pearson (chi-square); 2) the *p*-level; 3) a comparative study of the expected and the obtained results, and 4) the median.

Results

The results of the research demonstrate that the Chi-square level of reading literacy in the Kazakh language and the location and the types (private and state) of school is $\chi 2 = 92.451$ (see Table 1). The Chi-square level of reading literacy in Russian and the location and the types (private and state) of school is $\chi 2 = 205.232$ (see Table 2). It has been found that the chi-square level of reading literacy in English and the types (private and state) of school is $\chi 2 = 263.075$ (see Table 3). Sufficiently large and positive numbers of the chi-squared in the given correlations indicate a high degree of positive linear correlation between variables.

Since the level of $p \leq .5$ is often used as a criterion for establishing statistical significance of two variables among the experts of statistics (Brown, Amos, Mink, 1975; Wasserman, 2004), in this case it can be argued with a 95% probability, that the phenomenon studied was no accident and the value obtained $\alpha < .001$ in Tables 1, 2 and 3 indicates strong positive indisputable differences between the selected values of reading literacy in the three studied languages and the location and the types (private and state) of school, which effectively denies the likelihood of errors in the rejection of the null hypothesis. This influence is also evident in the fact that the "expected" and "obtained" results are not the same; the higher the difference between them is, the more influence the variables have on each other. This data shows the plausibility and validity of the data in the statistical analysis.

In all correlations "a received value" means the number of respondents who answered affirmatively to a question, which is located vertically, for example, in Table 2, the results of 19 public school students situated at the lower edge of the city correspond to the B1 level on the reading literacy in Russian. An expected value refers to the number of respondents who have had both characteristics presented vertically and horizontally, if the results would be evenly distributed among the respondents of this subgroup. For example, in the case of an even distribution of the results, not 19, but 25.3 of the respondents have scored points corresponding to the B1 level in reading literacy in Russian. The category "total" in each column represents the total number of respondents in this category, for example, the total number of respondents in all schools, having been tested at the C1 level on reading literacy in Russian is 47.

A comparison of median levels of reading literacy of students on the three languages by schools gives a more complete picture of the state of reading literacy among respondents. Table 4 illustrates that the highest result of reading literacy in the Kazakh language belongs to the students of central state schools (4.7) and the students of private schools (4.7), the lowest result belongs to the students of state schools, situated in the lower suburb of the city (4.07). In reading literacy in Russian, the students of private schools demonstrated the highest results (5.6), and the lowest was also from the students of state schools, situated in the lower suburb of the city (1.9). On the reading literacy in English the answers of state school students situated in the lower suburb of the city is equal to a zero result, and the students from the private schools were highest (4.3).

Thus, private school students showed good results in the Russian and English languages, and the scores of the students of central state schools are higher on reading literacy in the Kazakh language and higher than other groups' scores. Pupils of schools situated in the lower suburb of the city are behind on reading literacy in all three languages studied.

Table 1. Correlation: Location and ownership type of schools/reading literacy in the Kazakh language

		Reading literacy in the Kazakh language							Total
		Missed	A1	A2	B1	B2	C1	C2	
State schools situated in the lower suburb of the city	Obtained	3	33	25	34	16	12	0	123
	expected	1.2	15.3	14.9	33.1	29.8	21.5	7.0	123.0
State schools situated in the center of the city	Obtained	0	3	7	28	30	18	14	100
	expected	1.0	12.5	12.1	26.9	24.2	17.5	5.7	100.0
Private schools	Obtained	0	1	4	18	26	22	3	74
	expected	0.7	9.2	9.0	19.9	17.9	13.0	4.2	74.0
Total	Obtained	3	37	36	80	72	52	17	297
	expected	3.0	37.0	36.0	80.0	72.0	52.0	17.0	297.0

Chi-Squared: $\chi 2 = 92.451$; $df = 12$; α (2-tailed) $< .001$

Table 2. Correlation: Location and ownership type of schools / reading literacy in the Russian language

		Reading literacy in the Russian language							Total
		Missed	A1	A2	B1	B2	C1	C2	
State schools situated in the lower suburb of the city	Obtained	13	49	28	19	12	1	1	123
	expected	5.4	22.4	14.5	25.3	29.4	19.5	6.6	123.0
State schools situated in the center of the city	Obtained	0	5	7	31	40	16	1	100
	expected	4.4	18.2	11.8	20.5	23.9	15.8	5.4	100.0
Private schools	Obtained	0	0	0	11	19	30	14	74
	expected	3.2	13.5	8.7	15.2	17.7	11.7	4.0	74.0
Total	Obtained	13	54	35	61	71	47	16	297
	expected	13.0	54.0	35.0	61.0	71.0	47.0	16.0	297.0

Chi-Squared: $\chi 2 = 205.232$; $df = 12$; α (2-tailed) $< .001$

Table 3. Correlation: Location and ownership type of schools / reading literacy in the English language

		Reading literacy in the English language							Total
		Missed	A1	A2	B1	B2	C1	C2	
State schools situated in the lower suburb of the city	Obtained	63	50	10	0	0	0	0	123
	Expected	26.9	30.6	13.7	31.9	10.8	7.5	1.7	123.0
State schools situated in the center of the city	Obtained	2	24	19	45	9	1	0	100
	Expected	21.9	24.9	11.1	25.9	8.8	6.1	1.3	100.0
Private schools	Obtained	0	0	4	32	17	17	4	74
	Expected	16.2	18.4	8.2	19.2	6.5	4.5	1.0	74.0
Total	Obtained	65	74	33	77	26	18	4	297
	Expected	65.0	74.0	33.0	77.0	26.0	18.0	4.0	297.0

Chi-Squared: $\chi 2 = 263.075$; $df = 12$; α (2-tailed) $< .001$

Table 4. Distribution of median of reading literacy by schools

	Median of reading literacy in the Kazakh language	Median of reading literacy in the Russian language	Median of reading literacy in the English language
Average median by all schools	4.4	4.9	4.6
State schools situated in the lower suburb of the city	4.07	1.9	0.0
State schools situated in the center of the city	4.7	4.5	3.7
Private schools	4.7	5.6	4.3

Discussion

As a result of the analysis we can say with confidence that the correlation between reading literacy and the types (private and state) and locations of the school is linear and positive. The location of schools in prestigious areas and non-public (private) schools presuppose higher levels of reading literacy amongst their students.

The reason for the varied results of reading literacy among representatives of different segments of the population are due firstly, to differentiated distribution of economic benefits and financial resources. Financial opportunities of parents determine the location of the place of residence, the location and ownership type of the school. Factors such as the protected area of the school, fewer students in classes, additional services (meals, after-school clubs, self-study hours, etc.), a sense of belonging to the "elite", etc. attract parents with "opportunities". The same cannot be said about the parents of the disadvantaged sections of the population. The children of these families go to the nearest school to their home and visit clubs that are in the school or within their residential areas, or they simply do not attend clubs at all. Accordingly, the children of this group, in most cases, are more likely to fall behind in academic performance. It should be noted that an international comparative study of the quality of education provided by state and non-state educational institutions of different countries was previously conducted by economists Bertola and Checchi. According to the results of their research, in Kazakhstan, "private traders" are learning about 50 points better than "public figures" (Bertola & Checchi, 2013). Bertola and Checchi took the data from the International Student Assessment Program as the basis for calculating the study and found that in most countries of the world the situation is this: the more expensive schooling is, the better it is. This is especially pronounced in countries where the majority of the population are poor and public education leaves much to be desired - in Venezuela, Kyrgyzstan, Panama, Brazil. However, in developed countries like the USA and the UK, tuition at paid schools also usually guarantees a better education. In addition, where only basic education is given in public schools, the private sector attracts the best students and contributes to their great achievements, which is happening both in the USA, Canada and the UK, as well as in Brazil and Uruguay.

Secondly, the results of the questionnaire lead to the assumption that not all parents have enough time for useful and informative pasttimes with their children due to heavy

workloads or simply a lack of initiative. Parents who work long hours in often difficult working conditions, with lower wages have fewer opportunities to spend time with their children. Parents who have financial and material resources (e.g. for staff recruitment for accompanying children and private lessons at home, etc.) are able to compensate for their lack of parental attention. It is known from many scientific sources that a positive relationship between parents and children is based on material conditions (Chen, Kong, Gao, & Mo, 2018).

Thirdly, the respondents' answers show that the uneven distribution of information, as a result of the absence or inaccessibility of sources of information resources, creates a different educational and recreational environment for their children. Despite the fact that all public schools receive the same funding for computerization and equipping school libraries, not all school libraries and other information resources can meet the growing demand of the post-computer age generation. The current era is closely connected with and dependent on technology which dictates its own rules of existence in society and the need to consider the possibility of reading books either online or from the electronic media. However, the presence of such devices creates financial costs on the part of parents.

Conclusion

The study revealed a complex and complicated and at the same time, consistent picture of the relationship between socio-economic inequality and the level of reading literacy. Social and economic inequality has both current and prolonged effects on the whole educational process. Differences in the social and economic situation form the unequal starting opportunities for education, literacy acquisition and the development of reading skills. Possible macrosociologic and microsociologic factors that affect the differentiated nature of the results of monitoring reading literacy in the three languages studied weren't discussed in this article due to space constraints. Additionally, the biggest limitation is the very small sample size, which included only a few schools in Almaty. Therefore, this study is considered as a preliminary attempt to develop a methodology to examine the question of socioeconomics and its influence on literacy. Having been shown to be effective, this method could be expanded to a larger, national, and more representative sample.

This study demonstrated that the relationship of reading literacy and socio-economic stratification of the population is a multifaceted social and historical phenomenon, requiring careful examination from the standpoint of sociolinguistics.

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Understanding predictor effects of computational thinking skills and media and technology use and attitudes of pre-service teachers for STEM awareness

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Abstract

This study proposes and tests a model that explains STEM awareness of pre-service teachers by examining computational thinking skills, media and technology use and attitudes, and demographic variables including gender, high school type and parent educational background. A total of 337 participants who enrolled in education faculties at three state universities in different regions of Turkey participated in the study. "STEM Awareness Scale", "Computational Thinking Skills Scale", "Media and Technology Use and Attitudes Scale" and demographic information forms were used as data collection instruments. The data were analyzed through statistical tests including structural equation modelling. Fit indices of the established model were within an acceptable range. Analysis demonstrated a positive relation amongst computational thinking and media and technology use and attitudes and STEM awareness. In addition, results of structural equation modeling revealed that these factors were significant predictors of STEM awareness. Similarly, the study found that STEM awareness was significantly predicted by some demographic variables such as majors, age, and mother's educational background. Recommendations for educationalists and policymakers are proposed.

Keywords: STEM awareness, computational thinking, media and technology usage, pre-service teachers

Introduction

There has been a great emphasis on STEM (Science, Technology, Engineering, Mathematics) education, which integrates these four disciplines into a holistic approach to equip individuals with skills including problem-solving, critical thinking, creativity, and digital literacy to overcome real-world challenges. It is believed that STEM education plays an important role in the development of 21st century skills (Ergün, 2019). Core elements of these skills are identified as problem-solving, collaboration, critical thinking, creativity, self-awareness, and digital literacy (Ahonen & Kinnunen, 2015; Van Laar, Van Deursen, Van Dijk, & De Haan, 2017). Arguably, these skills can be attained through STEM or currently STEAM (Science, Technology, Engineering, Art, & Mathematics) education (Barak, 2017; Çorlu, Capraro, & Capraro, 2014). The theoretically advocated concepts in STEM education can be identified as critical thinking, creativity, analytical thinking, problem solving, design, production, originality, entrepreneurship and so on. In this context, a 21st century teacher is expected to have high-level skills, be technology literate, provide opportunities for students to prepare and develop materials, develop students' creativity, apply scientific research methods and techniques, and have entrepreneurial and innovative thinking. However, there are serious obstacles to the implementation of STEM education in many countries, especially in developing countries including Turkey. The fact that STEM disciplines are included in the curriculum as separate courses, the current school climate, inadequate teacher competences, and inappropriate measurement and assessment approaches are some of the obstacles (Capraro & Nite, 2014). Furthermore, there has been a steady decline in STEM areas career choice of students in Turkey (OECD, 2015; OECD, 2017a). More surprisingly, Turkey, the founding member of the Organization for Economic Co-operation and Development (OECD), has the lowest proportion of employed young adults, compared to the average of OECD countries (OECD, 2019). This situation confirms that urgent interventions should be made to encourage students to stay in the STEM pipeline and that STEM careers need to be promoted especially in developing countries like Turkey. More research is needed to identify what factors can enhance pre-service teachers' STEM awareness and increase their interest in pursuing STEM careers.

STEM and its social and economic value is high on the agenda of countries that desire to remain advanced and competitive (Yusoff, 2019). However, putting efforts into raising STEM to the desired level might be pointless without the required awareness, knowledge and interest. Considering the relevant studies in the literature (Bakırcı & Karışan, 2018; Erdogan & Ciftci, 2017), the first aspect of STEM awareness is perception regarding the benefits of STEM on students' skills such as problem-solving, critical thinking and analytical thinking. The second aspect of STEM awareness is perception regarding the effects of STEM on teachers' skills such as technology use, proactivity and planning. The last aspect of STEM awareness is perception regarding the effects of STEM on the subjects such as relationship with daily life, material traits, and hands-on activities. One of the most important steps to establish the integrated interdisciplinary approach brought by STEM in the education system is to ensure that teachers are fully aware of STEM education (Knowles, Kelley, & Holland, 2018) and develop a positive attitude towards STEM. It is important to develop awareness of STEM when considering failures in STEM fields and the decrease in the number of graduates in these fields. Enhancing students' awareness to pursue careers in STEM fields could help in developing 21st century skills (Kan & Murat, 2018).

Furthermore, universities, Council of Higher Education (CoHE) and the Ministry of National Education (MoNE) are the trivet of teacher education in Turkey. The faculties of education in universities are responsible for educating pre-service teachers. CoHE coordinates and regulates the curriculum for the teacher education programs and MoNE holds the responsibility for selecting new teachers to employ at public schools. These three major institutional stakeholders are involved in the teacher education system and prepare pre-service teachers for all education levels. Primary, secondary and high school teacher candidates take the Public Personnel Selection Exam (KPSS) in order to start working in a public school after graduating from the faculties of education. In the KPSS exam, which is a multiple-choice exam in the fields of general culture, general proficiency and educational sciences, there are no questions regarding subject matter knowledge. After this, they take field exams based on their specialism. Those who are successful in these two exams are interviewed to identify whether they have the necessary qualities to become a teacher. Candidates are appointed on the basis of their average scores from all these exams subject to the availability of placements. (MoNE, 2015).

Purpose of the study

The rise in importance of computation with respect to STEM fields is a primary motivation of this study. Since digital skills are considered as a core component for STEM disciplines (García-Peñalvo & Mendes, 2018; Hendry, Hays, Lynch, & Challinor 2016; Hunter & O'Brien, 2018; Scaradozzi et al., 2016), computational thinking skills as well as technology usage and attitudes may take a central role in STEM education as a means of driving higher-order thinking skills. It is argued that computational thinking particularly relates to the STEM fields (National Research Council, 2011). As Günbatar and Bakırcı (2019) suggest, computational thinking may have the most significant effect in STEM education, but has not yet sufficiently penetrated into education programs in Turkey. Therefore, possessing effective computational thinking skills may lead students to pursue STEM-related majors (Weintrop et al., 2016). The concepts and implementations of computational thinking and digital technologies appear to be fundamental in STEM education in terms of acquiring knowledge of the relevant disciplines. Here, a debate and discussion, for quick acceleration in awareness, interest, attitudes and skills for STEM, can be raised around key questions such as: How is computational thinking and digital technology use related to STEM awareness? To what extent does computational thinking and digital technology use predict STEM awareness? Our aim in this paper is to explore and develop on what characterizes computational thinking and technology use and attitudes to advance STEM education. The contribution of this work is to provide a model that can be used to enrich STEM education. For administrators and policy makers, the model is meant to help set priorities for STEM education in this data-driven era. Furthermore, enhancing understanding of how these concepts are related may also help stakeholders design better professional development interventions which consider teachers' needs.

Theoretical framework

Computational thinking has become increasingly predominant in the literature in recent years. Although there is no consensus on the definition of this term, it can be considered as a process of developing design, application and algorithmic thinking skills to solve a series of problems. It includes identifying a problem, understanding the problem, and introducing the algorithms for problem-solving (Brennan & Resnick, 2012; Román-González, Pérez-González, & Jiménez-Fernández, 2017). Similarly, Shute, Sun and Asbell-Clarke (2017) conceptualize computational thinking as having six basic pillars that are decomposition, i.e., breaking a complex problem into smaller units, abstraction, i.e., extracting the core features of complex problems, algorithm design, i.e., creating a series of ordered steps/instructions to implement solutions, debugging, i.e., identifying and fixing errors when solutions do not operate as expected, iteration, i.e., iterative process of patterns to accomplish the goal, and generalization, i.e., reusing problem-solving strategies in different contexts. Rather than raising generic arguments about computational thinking, this present study refers to the key elements highlighted by Korkmaz, Çakir and Özden (2017) and these are creative thinking, algorithmic thinking, critical thinking, problem-solving, cooperative learning and communication. In line with this perspective, the key features of computational thinking include problem-solving, understanding problems, formulating problems and algorithmic thinking (Liu & He, 2014; Wing, 2006; Wing, 2014). It was identified by the International Society for Technology Education as one of the seven skills that today's students should acquire (ISTE, 2016). Computational thinking employs common ways of mathematical thinking in the process of problem-solving, of engineering in designing and assessing a complex system and of scientific thinking in understanding concepts such as computability, intelligence, mind and human behavior (Wing, 2011). Similarly, Kalelioğlu (2015) emphasizes that computational thinking is an ability to abstract information through computer applications or to perform abstraction and modelling skills. From this point of view, it can be said that the goal of introducing the computational thinking is essential to prepare young generations for their futures and STEM education in this increasingly technological age.

Connectivity through mobile and digital technologies and the use of social media has grown worldwide. According to the Turkish Statistical Institute (TUIK), computer use was 59.6% and internet use was 72.9% within the 16-74 age group in Turkey in 2018 (TUIK, 2018). Furthermore, 83.8% of households had access to the internet from home. In addition, 51% of the population were active social media users (We Are Social, 2018). These stunning developments also have an impact on education which has a close relation with social change. That is, the classroom practices have greatly changed over time due to advancing technology. Effective and efficient use of current technologies is of great importance for teaching settings. At this juncture, teachers are key stakeholders in raising digitally literate students in the process of keeping pace with the fast and dynamic structure of the digital age and of evolving into an information society. Thus, the perceptions, beliefs, attitudes, and daily usage intensity of teachers are essential not only for effective use and adoption of digital technologies but also develop students' creativity, problem-solving and thinking skills, which are essential for both computational thinking and STEM education. We therefore proposed the following hypotheses:

H1 Pre-service teachers' computational thinking skills positively influence their STEM awareness.
H2 Pre-service teachers' media and technology use and attitudes positively influence their STEM awareness.
H3 There is a positive relation between computational thinking skills and media and technology and attitudes of pre-service teachers.

There is evidence that STEM-related course experience is a statistically significant indicator of success and that academic discipline is an important factor in STEM teaching (Günbatar & Bakırcı, 2019; Kokkelenberg & Sinha, 2010). Contrastingly, some studies indicate that particular students' characteristics, rather than STEM experience, are the key predictors (Wladis, Hachey & Conway, 2014). Arguably, the age and experience of teachers appears to influence the implementation of education in STEM disciplines in Turkey. Hence, we set forth the following hypotheses:

H4 STEM-related majors of pre-service teachers positively influence their STEM awareness.
H5 Pre-service teachers' STEM awareness is positively related to their age range.

Likewise, the literature varies with respect to investigation of the relations between STEM and gender-based differences. According to Hill, Corbett, and Rose (2010) women pursue STEM programs at lower rates than men and Wang and Degol (2013) state that women graduate with fewer than one-third of undergraduate degrees in mathematics, computer science, engineering, and the physical science. This indicates that females perceive STEM disciplines to be male gendered and are much more likely to pursue degrees outside of the STEM fields. As a result, females are often underrepresented in STEM-related professions (Shute et al., 2017). At this point, computational thinking may be considered to motivate individuals, females in particular, to major in science fields. However, there are other studies suggesting that women and men are equally committed to their academic careers in STEM (Xu, 2008). Therefore, we put forth the following hypothesis:

H6 Pre-service teachers' STEM awareness is positively related to their gender.

Furthermore, several studies demonstrate that there is a significant relationship between STEM and school-based factors. For instance, Maltese and Tai (2011) indicate that majority of students who specialize in STEM make that choice during high school. Similarly, Alacaci and Erbaş (2010) reveal that school type is a considerable factor in students' success in STEM subjects in Turkey. Thus, we generated the following hypothesis:

H7 Pre-service teachers' STEM awareness is positively related to their high school types.

In addition, Moakler and Kim (2014) find that students are more likely to choose STEM majors if they have parents with STEM occupations. Similarly, parents' educational background is influential on students' decisions on what to major in and ultimately, whether to earn a STEM degree (Crisp, Nora, & Taggart, 2009). In this framework, we put forth the following hypotheses:

H8 Pre-service teachers' STEM awareness is positively related to the educational backgrounds of their fathers.

H9 Pre-service teachers' STEM awareness is positively related to the educational backgrounds of their mothers.

We believe that it is essential to examine how important it is to raise awareness of STEM, a contemporary approach in education, in this century in which media and technology use has become widespread in all areas of life in the age of computational thinking. In this context, our primary interest in this study is in exploring how the aforementioned variables relate to STEM awareness and the extent to which STEM awareness among pre-service teachers is explained by computational thinking skills level as well as media and technology use and attitudes considering the variables of "majors, age, gender, high school type, parent educational background." That is, it was tested whether pre-service teachers' computational thinking levels and their media and technology usage and attitudes considering these variables predict their STEM awareness through a proposed model.

Method

This study proposes a model that explains and predicts the relations between computational thinking skills, technology usage and attitudes, STEM awareness and a set of other variables. Therefore, this research is a relational survey model (Karasar, 2005).

Research design

The conceptual research model is given in Figure 1.

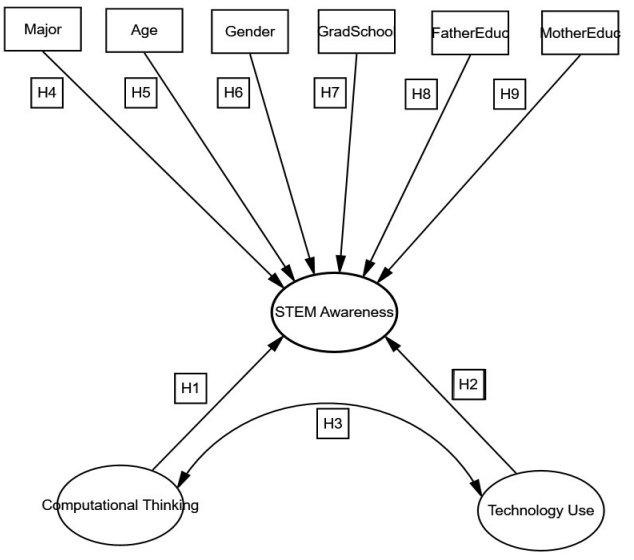

Figure 1. Conceptual research model

Participants

Participants comprise 377 undergraduate students who studied in the 2018-2019 academic year. These participants were selected using the convenient sampling method from non-random sampling methods and voluntarily involved in the research. The pre-service teachers studied in three different state universities in the south, north and central parts of Turkey. Participants' descriptive information is given in Table 1. To define a STEM major, we use the categorization utilized by the National Science Foundation Advance Program [NSFAP] (2001) where majors such as engineering, physical sciences, earth, atmospheric or ocean sciences, mathematical and computer sciences, and biological and agricultural sciences are considered to fall within the STEM category.

Table 1. Descriptive information about participants

Variable		Category	*N*	%	Variable	Category	*N*	%
Gender		Female	281	74.5	Age Range	17-19	141	37.4
						20-22	191	50.6
		Male	96	25.5		23 and above	45	12
Universities		B University	212	49.42	Mother Graduation	Elementary school	312	82.7
		A University	51	11.88		High school	47	12.5
		C University	39	9.09		University	18	4.8
Majors	Non STEM	Classroom teaching	120	31.8	Father Graduation	Elementary school	236	62.6
		Philosophy teaching	19	5		High school	94	25
						University	47	12.4
		Preschool teaching	38	10.1	Internet use freq	1-2 hours a day	32	8.5
		Guidance and psychological counseling	56	14.9		3-4 hours a day	144	38.2
		Physical education and Sports teaching	22	5.8		5 more hours a day	161	42.7
		History teaching	19	5		From 7 hours less in a week	40	10.6
	STEM	Religious sciences teaching	17	4.5	Graduation High School Type	Anatolian	225	59.7
		Science teaching	35	9.3		Science	57	15.1
		Primary Mathematics teaching	32	8.5		Private	42	11.1
		Health Sciences teaching	4	1.1		Vocational	18	4.8
		Arts education	15	4		Social	35	9.3

Three different regions were preferred in choosing the universities with official permits to reflect the overall country. University A, which was opted for conducting the study, is an institution preferred by students from different cultures in the capital city and has a STEM center. University A is one of the first universities to have an educational faculty in Turkey. University B was founded in 2008 and is generally preferred by students living in southern regions. It is a university with a STEM workplace within the education faculty. University C was also founded in 2008 and is situated in the northern part of Turkey. It is a university in which STEM studies are carried out within the faculty of education. Both Universities B and C are fresh and dynamic institutions. The main reason for choosing these three universities is that the participants were somehow familiar with STEM education.

A wide range of majors such as religion, guidance and psychological counselling, and arts were purposively included in the study. It was considered that inclusion of different disciplines in addition to STEM fields could have led to interesting findings. The educational backgrounds of pre-service teachers are also important as it is possible to become a teacher after graduating from different high schools in Turkey. For instance, a student who graduated from a teacher training high school can continue their undergraduate education in education faculties, and a student who graduated from a vocational and technical high school can also enroll in the education faculty. In this context, it was considered that high school types of pre-service teachers could be an important factor in the proposed model. Considering parental education, the majority of mothers are primary school graduates as are the fathers. However, fathers appear to graduate with a slightly higher level than mothers.

Data collection instruments

Computational Thinking Scale was developed by Korkmaz, Çakir and Özden (2017) for university students. It consists of 29 items and five factors in total. "Creativity" (α = .84) sub-dimension consists of 8 items (e.g. I believe I can solve problems that may arise when I experience a new situation). "Algorithmic Thinking" (α = .86) sub-dimension consists of 6 items (e.g. I can immediately set up the equation to solve a problem). "Cooperation" (α = .84) sub-dimension consists of 4 items (e.g. I like to have cooperative learning experiences with my group friends). "Critical Thinking" (α = .78) sub-dimension consists of 5 items (e.g. There is a systematic method that I use when comparing and making choices) and "Problem Solving" (α = .72) sub-dimension consists of 6 items (e.g. I have difficulty in imagining the solution of the problem in my mind). Goodness of fit indices revealed that the model was confirmed and this structure is valid for measuring computational thinking ($\chi 2$ = 1169.93, d = 362, p < .01, CMIN/DF = 3.23, RMSEA = 0.06, SRMR = 0.04, GFI = 0.91, AGFI = 0.90, CFI = 0.95, IFI = 0.97). Cronbach alpha (α) consistency coefficient observed for the scale used in this study is at a high level (.85).

Media and Technology Usage and Attitudes Scale was developed by Rosen,Whaling, Carrier, Cheever, and Rokkum, (2013) and was adapted into Turkish by Özgür (2016). It consists of 60 items and 15 factors in total. "Smartphone usage" (α = .89) sub-dimension consists of 9 items (e.g. Accessing the internet on mobile phone), "general social-media usage" (α = .82) sub-dimension consists of 9 items (e.g. Checking Facebook page or other social networks), "internet searching" (α = .78) sub-dimension consists of 4 items (e.g. Searching on the internet to obtain information via any devices), "E-mailing" (α = .74)

sub-dimension consists of 4 items (e.g. Receiving, reading and sending emails (except spam or junk e-mail), "media sharing" (α = .85) sub-dimension consists of 4 items (e.g. Sharing your own media files such as photos and videos on the computer), "text messaging" (α = .76) sub-dimension consists of 4 items (e.g. Receiving and sending text messages (SMS) by mobile phones), "video gaming" (α = .71) sub-dimension consists of 3 items (e.g. Playing games on your own on PC, video console (PlayStation, Xbox, etc.) or on your smartphone) , "phone calling" (α = .84) sub-dimension consists of 2 items, "television viewing" (α = .83) sub-dimension consists of 2 items (e.g. Watching programs, films, etc. on TV), "online friendships" (α = .85) sub-dimension consists of 2 items (e.g. How many people have you met online with whom you have never met face-to-face?), "social media friendships" (α = .87) sub-dimension consists of 2 items (e.g. How many of your friends do you personally know on Facebook?) , "positive attitude towards technology" (α = .76) sub-dimension consists of 6 items (e.g. I feel it's important to be able to access any information online whenever I want), "anxiety and dependence" (α = .74) sub-dimension consists of 3 items (e.g. I feel worried when there is no access to the internet), "negative attitude towards technology" (α = .82) sub-dimension consists of 3 items (e.g. New technologies make life more complicated) , and "multitasking preferences" (α = .82) sub-dimension consists of 4 items (e.g. I prefer to work on various projects throughout the day instead of finishing long term projects and moving on to another). Goodness of fit indices revealed that the model was confirmed and this structure is valid to measure media and technology use and attitudes ($\chi 2 = 4330.49$, $d = 1605$, $p < .05$, CMIN/DF = 2.69, RMSEA = .04, SRMR = .046, GFI = .93, AGFI = .91, CFI = .95, IFI = .95). Cronbach alpha (α) consistency coefficient observed for the scale in this study is at a high level (.94).

STEM Awareness Scale was developed by Çevik (2017) to identify the STEM awareness of teachers. It consists of 15 items and three factors. "effects to student" (α = .81) sub-dimension consists of 6 items (e.g. STEM improves students' analytical thinking skills), "effects to course" (α = .71) sub-dimension consists of 5 items (e.g. High-level materials are needed for STEM), and "effects to teacher" (α = .70) sub-dimension consists of 4 items (e.g. Teachers can easily plan STEM education in in-class / extra-curricular activities). Goodness of fit indices revealed that the model was confirmed and that this structure is valid for measuring STEM awareness ($\chi 2 = 156.87$, $d = 247$, $p < .01$, GFI = 0.92, AGFI = 0.90, SRMR = 0.057, NFI = 0.94, NNFI = 0.96, CFI = 0.97, IFI = 0.96). Cronbach alpha consistency coefficient observed for the scale in this study is at a high level (.82). All data collection instruments were digitalized and sent in one batch to the participants online by using Google Forms. The scales were applied online through mobile phones, laptops or computers during a course hour (40 minutes) approved by the department head and accepted by the course instructor. For this, a faculty member working in these three education faculties of three different universities was assigned as responsible by the department. The responsible faculty members were informed by the researchers about the study and then they briefly informed the participants and stated that participation was on a voluntary basis. The responsible faculty member was contacted and notified when deficiencies were identified. Thus, data losses were prevented so far as possible.

Data analysis

In the present study, structural equation modeling (SEM), which is one of the methods

frequently used in social research in recent years, was applied. SEM is a powerful statistical technique that establishes measurement models and structural models. On the other hand, regression is considered a sophisticated and well-developed modeling approach to data analysis (Nusair & Hua, 2010). SEM is a statistical methodology combining the strength of factor analysis and path analysis. It is carried out by constructing a measurement model and a structural model. The measurement model identifies relations between observed and latent variables. By means of confirmatory factor analysis, the measurement model provides the link between scores on an instrument and the constructs that they are designed to measure. SEM identifies casual relations among the latent variables by specifying that particular latent variables directly or indirectly influence certain other latent variables in the model (Byrne, 2001). When research questions are raised to address relationships between latent variables in a study, SEM is probably a good choice according to regression (Nusair & Hua, 2010). Beyond the difference between the incorporation of manifest variables versus latent variables, Bollen and Pearl (2013) argue for much deeper differences between regression analysis and SEM (and also path analysis). As a result, they state that SEM has stronger aspects than regression. Similarly, Dursun and Kocagöz (2010) report that the low regression value of the variance explained in other analytical methods such as progressive or logistic regression may result from the difficulty of investigating indirect effects in such methods. The result of the difference is important in explained variances. In multivariate model analysis, the aim is to see the extent to which a change in one variable among the independent variables will lead to alterations in the dependent variable. However, to identify to what degree independent variables explain the change in the dependent variable, it would be more reasonable to use SEM. Therefore, SEM was used to examine relations between STEM awareness of teachers and various variables and a model was created by means of the AMOS 21.0 program to reveal the strength of computational thinking and media and technology usage and attitudes to predict their STEM awareness by identifying the effect of these variables on STEM awareness. To examine the compatibility level of relation patterns in the proposed model, $\chi 2$ (chi-square fit index test), RMSEA (the root mean square error of approximation), GFI (goodness of fit index), CFI (comparative factor index), NFI (normed fit index) fit index tests were used and analyzed.

The scores of the dependent and independent variables were subjected to the two-step cluster analysis because the participants in the study group could display a heterogeneous structure in terms of the scores obtained from the data collection instruments and therefore the participants could have come from separate universes. Two-step cluster analysis is a multivariate statistical analysis that divides a heterogeneous sample into a homogeneous sub-group and calculates the descriptive measures of the homogeneous groups in a different way. The normality distribution of the total scores obtained from the data collection instruments applied in the study was analyzed using the Kolmogorov-Smirnov test. In the cluster analysis, only the normality of distance values is considered sufficient despite the assumption of normality with respect to the data (Tatlıdil, 2002). The Kolmogorov-Smirnov test can be used for this. The data obtained from the participants were first subjected to the two-step cluster analysis and then examined with SEM. Before the model was designed, multivariate and univariate normality had been checked in all data sets prepared for analysis by removing missing data with the listwise method for major, age, gender, high school, father's education background, and mother's education background. It was observed that most of the variables did not meet the assumption of normality criteria. Based on this, robust maximum likelihood estimation method (RMLE) was employed in the analyzes and

asymptotic covariance matrices were formed. Firstly, the model was imagined for each possible value and tested to see whether model fit values, standardized factor loads, error values, path coefficients were significant. Then the model was tested for all groups and all possible values and the model fit was examined for each group. Finally, for each independent variable, the model considered each possible value and the mean of fit indices and path coefficients were examined together with their significance, and standardized factor loads and error values were examined separately for all possible values.

Both categorical and continuous variables were used in this study. Firstly, normality distribution of the continuous data was examined with skewness and kurtosis coefficients. Since these coefficients were close to zero (highest = 0.77, lowest = 0.11), it was confirmed that the data were normally distributed. In addition, histogram and p-plot graphs were examined for continuous data and it was observed that variable errors indicated normal distribution. The distribution of variable errors and the estimated values of the variable errors on the scatterplot were examined and it was observed that assumption of covariance was provided.

Table 2. Pearson product moments correlation coefficients for all variables (n =377)

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. STEM Aw.	1								
2. CT	.26**	1							
3. MTUA	.17**	.27**	1						
4. Major	-.11*	-.09	-.04	1					
5. Age	.12*	.06	-.05	.42**	1				
6. Gender	-.10	.07	.07	.13**	1	1			
7. High_School	-.08	-.07	-.07	.06	.00	-.02	1		
8. F. Educ.	-.07	.09	-.04	-.15**	.02	-.05	-.03	1	
9. M.Educ	-.12*	.00	.04	-.10*	.00	-.04	-.10*	.05**	1

* $p < .05$, ** $p < .01$

STEM Aw.: STEM Awareness, CT: Computational Thinking, MTUA: Media and Technology Use and Attitude

Table 2 shows that STEM awareness and computational thinking scores were positively and moderately significant ($r = .26$, $p < .01$). Similarly, it is seen that STEM awareness and MTUA scores were positively and moderately significant ($r = .17$, $p < .01$). Furthermore, there were a positively and moderately significant correlation between CT and MTUA ($r = .27$, $p < .01$). STEM awareness and major scores were negatively and lowly significant ($r = -.11$, $p < .05$), STEM awareness and age scores were positively and lowly significant ($r = .12$, $p < .05$), and STEM awareness and mother education background scores were positively and lowly significant ($r = -.12$, $p < .05$). After examining the relationships between the predicted and predictor variables in the study, the predictive effects of computational thinking, MTUA, major, age and mother education background on STEM awareness were tested by path analysis.

Ethical approval

This study was approved by the Scientific Research and Ethical Council (IRB), Karamanoğlu Mehmetbey University, Turkey, (IRB no. 01/01/2018). Informed consent was obtained from the participants.

Findings

Just before testing the hypotheses, cluster analysis was employed to reveal a more detailed result in determining the scores (Table 2). The lowest score that can be obtained from the STEM awareness scale is 15 and the highest score is 225. The higher the scores the higher the STEM awareness level. The distribution of normality for the overall scale was tested with Kolmogorov-Smirnov. Accordingly, it was observed that the total score variable of the dimensions did not show normal distribution ($p < .01$). Due to this finding, descriptive statistics regarding the total score variable were determined as median and quarter deviation. The median value of the scale was 57.00. This score was accepted as the threshold value. When the score is subjected to clustering, as shown in Table 3, the first cluster included the group with "lack of awareness", the second cluster included the group with "low awareness", and the third cluster included the group with "high awareness".

Table 3. Two step cluster analysis for STEM awareness

Cluster	*n*	X	%
1. Lack of Awareness	120	45	32
2. Low Awareness	102	57	27
3. High Awareness	155	63	41

STEM awareness was low and high for individuals with item total score above the threshold and those with item total score below threshold had no STEM awareness, as seen in Table 3. Almost half of the pre-service teachers participating in the study had high STEM awareness, followed by lack of awareness and low awareness.

When computational thinking skills scores of the participants were subject to the clustering analysis (Table 4), the first cluster included the group with "lack of computational thinking skills", the second cluster included the group with "low computational thinking skills", and the third cluster included the group with "high computational thinking skills". The lowest score that can be obtained from the Computational Thinking Skills scale is 29 and the highest score is 145. The higher the scores, the higher the level of computational-thinking skills. The distribution of normality for the overall scale was tested with Kolmogorov-Smirnov. Accordingly, it was observed that the total score variable of the scale did not show normal distribution ($p < .05$). Due to this finding, descriptive statistics regarding total score variable were determined as median and quarter deviation. The median value of the total score variable of the scale was 100.00. This score was accepted as a threshold.

Table 4. Two step cluster analysis for computational thinking skills

Cluster	*n*	X	%
1. Lack	98	63	26
2. Low	152	96	40.3
3. High	127	105	33.7

As seen in Table 4, almost half of the pre-service teachers participating in the study had low computational thinking skills followed by high and lack.

The lowest score from the Media and Technology Usage and Attitude scale is 60 and the highest score is 600. The higher the scores, the higher the media and technology usage and attitude level. The distribution of normality related to the overall scale was tested with Kolmogorov-Smirnov. Accordingly, it was observed that the total score variable did not show normal distribution ($p < .01$). Due to this finding, descriptive statistics regarding total score variable were determined as median and quarter deviation. The median value of the total score variable was found as 356. This score was accepted as the threshold value. When the obtained score was subjected to clustering, as shown in Table 5, the first cluster included the group with "lack of media and technology use and attitude", the second cluster included the group with "high of media and technology use and attitude".

Table 5. Two step cluster analysis for media and technology usage and attitudes

Cluster	*n*	X	%
1. Lack	142	288	37.7
2. High	235	347	62.3

It was considered that media and technology usage and attitude is high for individuals whose item total score is above the threshold values and insufficient for individuals whose item total score is below the threshold value. It can be said that the pre-service teachers participating in the study had high media and technology usage and attitude levels.

Based on the clustering analysis, the majority of pre-service teachers participating in the study had low or insufficient STEM awareness, partial computational thinking skills and sufficient media and technology usage and attitudes in general. Figure 2 displays coefficients of the structural equation model formed by the variables selected in line with the data. Relationships between "major, age, and mother's education background,", which are endogenous variables to predict "STEM awareness" latent variable, which was the predicted variable of the research and "computational thinking" and "media and technology usage and attitudes" were displayed by the path diagram. Prior to identifying the correlations with the structural equation model, it is necessary to test fit indices of the measurement model with latent variables. The fit indices criteria and the values obtained in the research are given in Table 6.

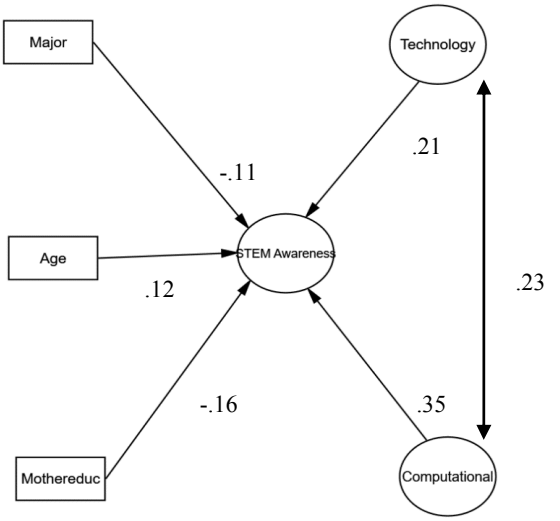

Figure 2. Path diagram to predict STEM awareness

The model fit indices of the established model in Figure 2 were initially examined without applying any modification process, but it was observed that the model did not meet the goodness of fit criteria ($\chi 2$ = 1252.38, *sd* = 296, $\chi 2/sd$ = 4.23, RMSEA = .093, SRMR = 3.61 CFI =.68, GFI = .77, NFI = .62, TLI = .65). Then the suggested modifications for the model were examined considering the literature and errors related to variables were associated with two-way covariance. After this modification process, it was observed that the model met the goodness of fit criteria, which means the data obtained by the established model in the study were a sufficient fit and the model was approved (Table 6). It was seen that fit indices that were examined to identify efficiency level of the structural equation model have good fit with the calculated values (Bentler, 1980; Brown & Cudeck, 1992).

Table 6. Fit indices of the model

Indices	Perfect Fit	Acceptable Fit Criteria	Values Obtained	Status
[1]χ^2/sd	$0 \leq \chi^2/sd \leq 2$	$2 \leq \chi^2/sd \leq 5$	2.3	Acceptable Fit
[2]CFI	.95 ≤ CFI ≤ 1.00	.90 ≤ CFI ≤ .95	.91	Acceptable Fit
[2]NFI	.95 ≤ NFI ≤ 1.00	.90 ≤ NFI ≤ .95	.90	Acceptable Fit
[2]TLI	.95 ≤ TLI ≤ 1.00	.90 ≤ TLI ≤ .95	.90	Acceptable Fit
[2]IFI	.95 ≤ IFI ≤ 1.00	.90 ≤ IFI ≤ .95	.91	Acceptable Fit
[2]GFI	.95 ≤ GFI ≤ 1.00	.50 ≤ GFI ≤ .95	.88	Acceptable Fit
[2]AGFI	.95 ≤ AGFI ≤ 1.00	.50 ≤ AGFI ≤ .95	.84	Acceptable Fit
[3]RMSEA	.00 ≤ RMSEA ≤ .05	.05 ≤ RMSEA ≤ .10	.06	Acceptable Fit
[4]SRMR	.00 ≤ SRMR ≤ .05	.05 ≤ SRMR ≤ .10	.07	Acceptable Fit
[5]PCFI	Goodness of fit close to 1		.84	Acceptable Fit

[1] Kline (2011), Tabachnick & Fidell, (2007), Schermelleh Engel, Moosbrugger & Müller, (2003),
[2] Hair et al. (2009) Tabachnick & Fidell, (2007),
[3] Meyers, Gamst & Guarino, (2006),
[4] Brown & Cudeck, (1992), Schermelleh-Engel, Moosbrugger & Müller, (2003),
[5] Arbuckle (2003), Byrne (2001)

It is seen that "computational thinking", which consists of 5 sub-dimensions, is the most significant variable with the highest correlation coefficient (Y = .35), when examining variables predicting STEM awareness of pre-service teachers. The "critical thinking", one of the sub-dimensions, has the highest factor load. The correlation coefficient of "media and technology usage and attitudes", which has 15 sub-dimensions, is also high (Y = .21). "Social network usage", one of the sub-dimensions, has the highest factor load. Another variable that appears to be significant is "age" (Y = .12), followed by "mother's education background" (Y = -.16) and "major" (Y = -.11). The STEM awareness scale consists of 3 sub-dimensions and the "effect to students" sub-dimension resulted with the highest factor load.

At this stage, the effect size of path coefficients was examined. According to Kline (2011), if the path coefficient is less than 0.10, it can be interpreted as a small effect, about 0.30 as a medium effect, and if it is 0.50 and or above, it can be interpreted as a large effect.

Table 7. Hypothesis acceptance/rejection results

		β -coefficient	*t*-value	Effect Size/Correlation	Acceptance -/Rejection	*p*
H1	Media and Technology Use and Attitudes -STEM Awareness	.21	2.20	Moderate Effect	Acceptance	.02
H2	Computational thinking skills - STEM Awareness	.35	2.77	Moderate Effect	Acceptance	.00
H3	Media and Technology Use- Computational thinking skills	.23	1.87	Moderate Correlation	Acceptance	.04
H4	Majors - STEM Awareness	-.11	-1.97	Small Effect	Acceptance	.04
H5	Age - STEM Awareness	.12	2.07	Small Effect	Acceptance	.03
H6	Gender - STEM Awareness	-.48	-.93	-	Rejection	.58
H7	Graduated high school - STEM Awareness	-.02	-.16	-	Rejection	.89
H8	The educational background of fathers - STEM Awareness	-.01	-.06	-	Rejection	.80
H9	The educational background of mothers - STEM Awareness	-.16	-3.13	Small Effect	Acceptance	.00

As seen in Table 7, the highest path coefficients of the accepted hypothesis were computational thinking skills (.35) and media and technology use and attitude (.21) that were endogenous variables, respectively. Among the exogenous variables, the highest path coefficient to predict STEM awareness was educational background of the mother (-.16), while the lowest path coefficients to predict STEM awareness were age (.12), followed by the major variable (-.11). Similarly, a moderate correlation between computational thinking and technology and media use and attitudes was identified (r = .23, p < .05) and thus the hypothesis was accepted (H3).

The hypothesis that a high level of media and technology usage and attitudes of the pre-service teachers predicted their STEM awareness (H1) was confirmed with the established model. This indicates that media and technology use and attitude are closely related to STEM awareness. Similarly, the hypothesis about the relationship between the high STEM awareness of pre-service teachers who had computational thinking skills was confirmed with the established model (H2). Computational thinking skills and STEM awareness are two factors that affect each other because STEM is an approach that incorporates technology/design meaning that someone who has computational thinking skills would also have STEM awareness. The hypotheses that major (H4) and age (H5) variables significantly predict STEM awareness were confirmed with the established model.

Discussion and conclusion

According to results of SEM analysis, STEM awareness was significantly predicted by the variables of "computational thinking, media and technology usage and attitude, major, age, mother's educational background". Findings are in line with the results of various studies in the literature. For instance, there are a lot of studies reporting the positive effect of media and technology usage and attitudes (DeCoito & Richardson, 2018; Hunter, 2017; Karahan, Canbazoglu-Bilici, & Ünal, 2015; Wu & Anderson, 2015).

The result indicated that computational thinking is a positively significant factor in predicting STEM awareness. Some studies are consistent with this result (Beheshti, et al., 2017; Lee et al., 2011; Weintrop et al., 2016). Similarly, Calderon (2018) states that STEM subjects have higher impact on the students' performance in computational thinking components. There are also studies examining the impact of STEM activities on computational thinking skills carried out by collaborative learning and project-based learning strategies (Hsu, Chang, & Hung, 2018; Young 2018).

Another hypothesis accepted in the research is that majors of pre-service teachers are important in predicting their STEM awareness. This can be expected as some specialized schools offer advanced courses in STEM subjects. According to the established model, majors predict STEM awareness with a significant but negative effect. Although the majority of the pre-service teachers participating in the research were from STEM areas, this result may be influenced by the fact that a significant majority of them study in non-STEM areas. It is consistent with the result that STEM awareness is higher in STEM disciplines pre-service teachers (Asiroglu & Koc Akran, 2018). Similarly, Çevik (2018) states that STEM perceptions of engineer candidates are higher than pre-service teachers.

Another hypothesis confirmed in the study is that age of pre-service teachers significantly predicts their STEM awareness. This suggests that the number of years of teaching experience appears to influence the implementation of education in STEM. Some studies appear with the similar result in the literature. For instance, Çorlu, Capraro, & Capraro (2014) emphasize that age variable is one of the factors affecting the integration of STEM into schools in Turkey.

The gender variable did not have a significant effect on STEM awareness. This is in line with other studies that also report that gender did not have a significant effect on STEM awareness for both teachers and pre-service teachers (Bakırcı & Karışan, 2018; Bieri Buschor, Berweger, Keck Frei, & Kappler, 2014; Simon, Wagner, & Killion, 2017).

The mother's educational background is one of the factors that predicts STEM awareness. This may be because in Turkey mothers are mostly responsible for educating their offspring and fathers are mostly engaged in working life. Various studies similarly argue that STEM achievement of students increases as the education level of the mother increases (Aydeniz, 2017; Herdem & Ünal, 2018; Marotto & Milner-Bolotin, 2018). There are both formal and informal ways to involve a student's parents in STEM education; whether via email or a full-blown Family STEM Night plans, the key to successfully impacting student achievement and learning is using strategies that change the home dynamics long-term to promote parental engagement with at-home learning (Peterson, 2017). When children and parents work collaboratively on at-home learning, significant and meaningful improvements are observed in standardized test scores and grades (Altschul, 2011; Harris & Goodall, 2008). In terms of influencing a child's career development, parents are active agents (Young & Friesen, 1992), and are a stronger influence on the child's career choices than the peer network or the school (Schulenberg, Vondracek, & Crouter, 1984). To capitalize on that influence, parents need guidance.

In contrast, the predictive hypothesis of pre-service teachers' gender and graduated high school type was rejected by the model. Similarly, the educational background of the father was rejected. This result is in line with previous studies (Günbatar & Bakırcı, 2019; Tekerek & Karakaya, 2018). However, some studies indicate different results. For instance, Marino, Black, Hayes and Beecher (2010) state that father's and mother's education did not have significant effect on students' achievement in STEM-related courses. Similarly, Chachashvili-Bolotin, Milner-Bolotin and Lissitsa (2016) highlight that studying advanced science courses prior to higher education eliminates the effect of family background on students' interest in pursuing STEM fields in the future.

Policy implications

From the findings, we conclude that STEM awareness among pre-service teachers is still not sufficiently high and their perceived computational skills are inadequate. Findings also show that computational thinking skills and media and technology use and attitudes have a moderate effect on STEM awareness. Therefore, it can be argued that computational thinking skills and media and technology usage and attitudes of pre-service teachers should be enhanced to nurture their awareness of the importance of the STEM field. The findings remind teacher educators to pay attention to the potential spectrum of computational thinking and media and technology use to increase STEM awareness. In Turkey, an integrated STEM approach does not currently appear in the curriculum. Considering the recent reports and plans by the MoNE related to STEM education, this approach is on the agenda of MoNE. Despite this, the pace of this agenda is somewhat slow (Altunel, 2018). According to an OECD report, Turkey appears in the last place among 34 countries that are likely to lead in the STEM professions in the future (OECD, 2017b). As findings suggest, it is essential to include courses and activities that would internalize the STEM education approach to pre-service teachers and increase the quality of education faculties. For this purpose, we recommend increasing both the cooperation among science and engineering faculties and the number of workshops. Furthermore, pre-service teachers can prepare lesson plans including more examples of computational thinking integration in STEM skills and implement their lesson plans in teaching practices.

At the same time, in the realization of STEM education, it is vital to synchronize infrastructure, equipment, labs and the workplaces of education faculties with the STEM approach and revise curricula accordingly to create enculturation of STEM in educational settings. It can be expected that pre-service teachers with high computational thinking skills and who use media and technology effectively are more likely to be aware of STEM teaching and become motivated to implement STEM education. Thus, computational thinking and effective media and technology use should be embedded in teacher education programs. This can be achieved through establishing a mutual link between math, science and computational thinking and updating classrooms with best practices.

Furthermore, based on our findings, educational awareness of the parents, mothers in particular, should be raised to increase the numbers of pre-service teachers with high STEM awareness. Therefore, it is recommended to inform parents via effective platforms to have a clear understanding on the outcomes of STEM. Since mothers are influential in students' decision to choose the STEM stream, it is recommended that schools implement informative programs to create awareness of STEM careers for their children. Policy-makers and educational stakeholders should take measures for this. Based upon the major findings of this study, we propose a model, in which media and technology usage and attitudes and computational thinking skills are endogenous variables, major, age and mother's education level are as exogenous variables. This model can be considered to predict STEM awareness of pre-service teachers in Turkey.

Limitation and future studies

Different variables that predict STEM awareness could be employed in the model. For instance, the model could be structured by 21st century skills or science or math academic achievements. Another limitation is that a predictive exogenous variable was not employed in the model. Future studies could consider this in conducting further research. In addition, another limitation is that the study's participants could have been selected from other different universities and from different majors, and findings might be gender-biased due to large number of female participants in the study. On the other hand, it might be possible to obtain different results with a model in which computational thinking is centralized. In this regard, further studies are needed to investigate the contribution of computational thinking to STEM. In particular, realization of new models considering relations between approaches such as STEM, STEM+Arts, Technological Pedagogical Content Knowledge (TPACK) and computational thinking would contribute to our understanding.

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Small frog in a big pond vs. big frog in a small pond: Actual vs. perceived achievement gaps among Korean, Korean-American and American students

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Abstract

This study examines actual vs. perceived math achievement gaps (test scores vs. self-ratings) among Koreans, Korean-American immigrants and Korean-American natives. The study links TIMSS 2007 and ECLS-K 2007 8th grade math data together for matched comparisons. For actual achievement level, Korean students perform significantly better than Korean-American students who in turn perform better than other American students. For perceived achievement level, Korean students have significantly lower self-concept than both Korean-American and other American students. The findings imply that Korean students are akin to a 'small frog in a big pond', whereas Korean-American students are 'a big frog in a small pond'. This study gives new insights into multi-faceted, transnational achievement gaps and challenges Korean 'model nationality' or 'model minority' myths.

Keywords: math achievement, achievement gap, self-concept, model minority, Korean-American immigrant

Introduction

The study is aimed at understanding multi-faceted and transnational nature of the achievement gaps with focus on the case of Korean and Korean-American students. The study adds an international dimension to the research on achievement gaps between immigrants and native students in the U.S. Existing research on domestic, within-country achievement gaps has drawn heavily upon national achievement test samples (e.g., the U.S. National Assessment of Educational Progress data for American student achievement gaps). Although there are increasing references being made to high-performing countries based on international tests (e.g., the Trends in International Math and Science Study, TIMSS), research on domestic achievement gaps and international achievement gaps remains largely separate and traditionally has not informed one another. In an increasingly globalized world and internationally competitive higher education market, the problems of domestic achievement gaps (racial and social gaps within the U.S.) and international achievement gaps are intertwined (Lee, 2016). Fresh insights into achievement gap problems can be gained by integrating the two separate lines of analyses.

On one hand, the U.S. faces significant challenges of tackling enormous academic achievement gaps among different racial and ethnic subgroups of students within the nation. The task of narrowing this racial gap is complicated by growing immigrant student populations who bring cultural and linguistic differences to schooling. On the other hand, the U.S. also faces another daunting challenge of addressing large achievement gap relative to other developed countries (Baker, 2003). The gap between the average U.S. student and the average student from the highest-performing Asian countries (e.g., South Korea, Korea hereafter) in math is as large as or sometimes even larger than the within-country achievement gap among racial groups such as Black-White achievement gap (Lee, 2016). The domestic racial achievement gaps including immigrant vs. non-immigrant gaps may be examined in a larger international context, and in this paper we focus on the comparison of Korean-American students relative to Korean students as well as other American students.

The paradox of Korean education is that students are performing well on tests but feeling bad about their performance (Lee & Park, 2014). Similar tendency was found among other high-performing East Asian nations where students tend to have relatively lower self-concepts of ability (Stigler, Smith, & Mao, 1985; Whang & Hancock, 1994). According to typical TIMSS 8th grade math test results, Korean students perform at the top, while American students perform below the international average. The actual level of students' math performance measured by test scores is sharply contrasted with perceived level of math achievement reported by students; Korean students tend to report the lowest level of self-concept of mathematics achievement among all the TIMSS countries, while American students are placed in the top ranks. While the former U.S. President Obama during his presidency often mentioned the Korean education system as a model of educational success in terms of math achievement, those praises came as a surprise to many South Koreans at that time as the country's education system has been under constant public criticisms such as excessive academic competition and stress among students (The Korea Times, 2010).

A similar kind of paradox may happen to Asian-American students who may outperform other racial groups in schools but experience academic pressure and stress as a model minority group. Asian-American students report the most challenging trouble

threshold for school grades and the greatest fear of the consequences of not doing well in schools (Steinberg, 1996); the school grade trouble threshold, that is, the lowest grade that students think that they could receive without their parents getting angry, was C- for Blacks and Hispanics, B- for Whites, and A- for Asians. However, there can be significant "washaway" of Asian sociocultural influences among Asian-American immigrant students of the third generation and plus (Sue & Okazaki, 1990; Wang & Lin, 2005). Asian-American native students are more likely to experience the "big frog in a small pond" phenomenon; they maintain academic edge over other racial groups including White students and thus may feel an inflated sense of achievement in their school.

How do cultural and institutional differences between Korean and American education systems affect contradictory patterns of achievement gaps as measured by students' self-concept ratings vs. test scores? While the between-country gaps have been studied and known better, the question remains as to how the paradox of achievement result-perception gap plays out among Korean-American students in the United States. Korean-American students are more likely to become overachievers through higher academic expectations. At the same time, Korean-Americans are still relatively immune from academic pressure at both home and school, compared to their counterparts in Korea where academic competition for college entrance is much more intense. This study examines the pattern and extent of math achievement gaps (both test scores and perceptions) among Koreans, Korean-American Immigrants, and Korean-American Natives.

By addressing those questions, the findings of this study can not only advance our understanding of math achievement gaps but also help inform contemporary education reform policy initiatives within and beyond the U.S. While the past U.S. education accountability policy focused on improving academic achievement as measured by standardized tests (e.g., the No Child Left Behind Act), there are increasing state policy efforts under the Every Student Succeeds Act of 2015 to improve students' socioemotional skills and mental health while also improving their college and career readiness. The same can be said about Korean education reform policy efforts such as the Character Education Promotion Act of 2015 that attempt to address increasing socioemotional and behavioral problems among school children and youths while introducing more student-centered innovative school curriculum for college and career readiness. Given tensions among multiple educational goals and policies, international perspectives can help broaden comparative benchmarks and references to rethink educational problems and solutions.

Research frameworks and perspectives

This international comparative study intends to further theoretical knowledge of achievement gaps in its examination of U.S. domestic and international achievement gaps measured in students' test scores and perceptions and of the dynamic influences on the comparative achievement gaps. In this study, achievement gaps--conventionally understood as "[p]ersistent differences in achievement among different groups of students as indicated by scores on standardized tests, grades, levels of educational attainment, graduation rates, and other data" (Ravitch, 2007, p. 9) are not defined merely as the binary group differences between the dominant reference group and the rest, traditionally, White students and minorities--Black, Hispanic, or Asian American--in the United States (Lee, 2016). Addressing

the need to expand the traditional, singular definition (Carpenter, Ramirez, & Severn, 2006) and also to shed insights on the existing relationship between cultural community practices and individuals' repertoires of cultural practice (Gutiérrez & Rogoff, 2003), this study assumes and further examines the plurality of within- and between-group differences among multiple student populations. Understanding the achievement gaps phenomenon should include considerations of the complexity of dynamic cultural-historical and educational environments as well as racial and ethnic cultural heritage and immigration generation status.

The achievement gaps problems are, thus, newly and operationally defined as "*any measured difference between how children learn and grow (actual learning growth) and how children could learn and grow under ideal circumstances (desired learning growth)*." (Lee, 2016, p. 15, emphasis in italics original) In regards to the new definition above, Lee's dynamic, multi-componential model (2016) of Balanced Achievement Gap Management System (BAGMS hereafter) offers an explanatory lens with which to reframe the notion of achievement gaps and to further the understanding of the dynamicity of the phenomenon influenced by an increasing number of identified and potential factors on the achievement gaps trends. According to the BAGMS model, achievement gaps result from the discrepancy between desired achievement goals--in other words, Desired Achievement Level (DAL)--and current achievement status--Actual Achievement Level (AAL). DAL can be oriented by standards and/or norms set for the target student (sub)population in a particular education system and, additionally, by subgroup-specific needs related to situated environmental conditions and individual students' learning growth potential. Students' socially constructed background characteristics such as race and ethnicity, socioeconomic status, and nationality influence both DAL and AAL and resulting achievement gaps (see Figure 1; Lee, 2016 for details of the BAGMS model). The achievement gaps are likely to affect student attitude and disposition including Perceived Achievement Level (PAL). A manageable level of "positive" achievement gaps (DAL > AAL) is healthy and can be conducive to achievement gain by bringing more learning opportunities and engagement efforts. However, excessively large gaps (as a result of unrealistic achievement goals) can be harmful by depressing academic self-efficacy and improvement. At the same time, too much "negative" gaps as a result of artificially lower expectations and overpraise may lead to an illusion of proficiency and can be detrimental to potential growth.

Additional theoretical constructs that aid in delving into the BAGMS components of interconnected influence and, thus, guide the interpretation of measured achievement gaps in test scores and perceptions by Koreans, Korean-American Immigrants, and Korean-American Natives concern differences in terms of sociocultural ecologies of standards and expectations and frames of comparative reference, to be discussed in turn.

First, culture, often viewed as the significant influence on Asian immigrant students' high academic achievement, is not without debates on its nature. Culture is not framed, in this study, as an inherent, unvarying endowment to all individuals with the common cultural origin or heritage (Fukuyama, 1993), which may not only neglect within-group differences and but also dangerously lead to perpetuating the 'model minority' myth (Lee, 2009). Similar reasoning against stereotyping applies to refute the myth of the 'culture of poverty' (Lewis, 2011) that tends to wrongfully position the culture of lower socioeconomic cultural groups as deficient thus resulting in stereotyped minoritized--Black or Hispanic--students' underachievement (Gorski, 2008), compared to higher achieving Asian American or White peers.

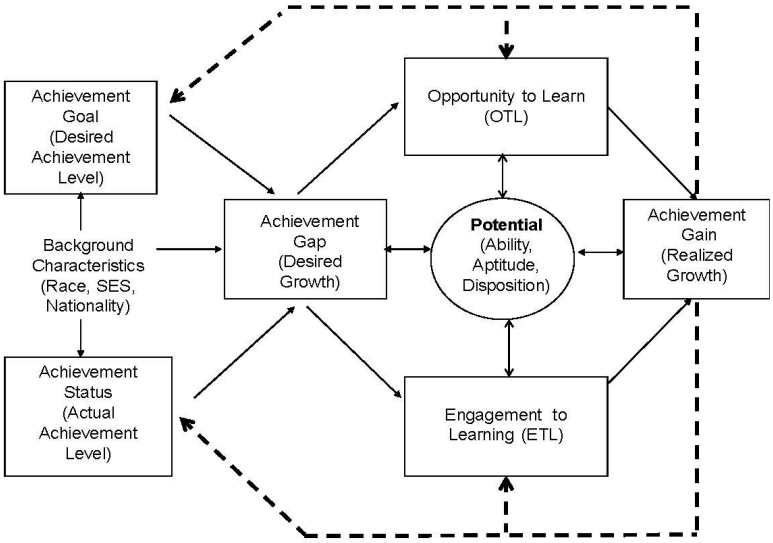

Figure 1. Model of Balanced Achievement Gap Management System (BAGMS)

Rather, the role of culture is conceptualized as a social 'structure' (Zhou & Kim, 2006) or a cultural-ecological 'environment' (Ogbu & Simons, 1998). On one hand, this notion supports and strengthens the traditional Confucianist and collectivist cultural value of education for the success of the group and the individual as an organic part within the cultural group (Gudykunst, 2004) and also fosters immigrants' heightened view of education as the effective means toward social mobility in the United States (Sue & Okazaki, 1990) in its culture-structural interaction through ethnic 'community forces' (Ogbu & Simons, 1998) or, in other words, cultural resources and developing 'social capital' (Bourdieu, 1986) —the aggregate of the actual or potential resources linked to membership in a group. Thus, culture as the socioecological structural drive may influence Korean American students' Desired Achievement Level in the sociocultural standards and expectations, Actual Achievement Level, thus, the achieving gaps (Lee, 2016) and also Perceived Achievement Level (introduced above).

Further, important variations among students with same ethnicity and cultural heritage —Koreans, Korean-American immigrants, and Korean-American natives in this study—may be understood in terms of, among other factors, the extent of their comparative participation in the cultural 'repertoires' of their origin or heritage (Gutiérrez & Rogoff, 2003) and the relative differences in their status frames of reference (Ogbu & Simons, 1998) that may account for the reversed pattern of the students' perceptions of their academic achievement.

Understanding Korean cultural ways, repertoires, or 'styles' of learning would help explain that the pattern and extent of variations among Korean—native or immigrant—students' achievement gaps lies in the comparative "proclivities of people with certain histories of engagement with specific cultural activities" (Gutiérrez & Rogoff, 2003, p. 19), or in other words, families and communities'—not merely the students'—experience participating in cultural practice, in particular, toward academic achievement in the interest of this study. For example, the levels of parental involvement (Kim, 2002) as learners' social capital and educative community environment (Zhou & Kim, 2006) as students' educational

ecology contribute importantly to the observed phenomenon with Korean-American immigrant and Korean-American native high achievers in the United States.

In addition, a stronger manifestation of educative ecology with much heightened levels of engagement in achievement-oriented ways of learning is noted with the values, standards, expectations, goals, and behaviors/practices of individuals, families, formal schools, supplementary academic programs, and the broad-based society in Korea. The persistent phenomenon of 'education fever' in Korea is interdependent on the nation's notable economic development, and the educational zeal continues to propel rigorous investment in education in societal and individual levels, which is fueled by and also leads to intense academic competition among students for high-stakes college entrance to gain social mobility and status and economic prosperity in the status-driven, competitive capitalist industrial environment (Seth, 2002). The sustainability of the nationwide—and possibly transnational depending on the comparative strength of Korean-American students' participation in the Korean education fever repertoires (Gutiérrez & Rogoff, 2003)—cultural activities is systemically coordinated by the traditionally centralized educational system (Seth, 2002) that operates national standards, curricula, assessments, and teacher certifications.

To elaborate on the transnational nature of the Korean achievement orientation and investment, immigrants and their children may participate in such cultural repertoires, whether on the peripheries, in the new ecological center created in the new society, or in between. Varying degrees of the engagement and resulting achievement gaps and gains can be accounted for in part in terms of immigration generation status—third generation and plus Asian-American students' experience of 'washaway' of Korean macro sociocultural influences (Wang & Lin, 2005)—and 'voluntary' minority group members' comparative status frames of reference in the ecological continuum (Ogbu & Simons, 1998) of their overall identity work. The ways voluntary (immigrant) minorities view their dual worlds and behave in them include their perceptions of—for example, Perceived Achievement Level—and responses to education—including measurements in achievement test scores. The dynamic nature of the frames of reference defined as "the way a person views a situation" explains voluntary minorities'—not only the first generation—use of non-singular frame of reference, one based on their current situation in the new society, and the other rooted in their place of origin or heritage. In comparison with the 'back home' situation that the immigrants or their children may or may not have experienced firsthand, the minorities may take a positive view of the opportunities in the United States, which may lead to positive achievement gains whereas involuntary immigrants may show different, oppositional frames of reference (Ogbu & Simon). Taking within- and across-group heterogeneity of individuals' conditions and experiences into consideration, this study importantly acknowledges the existence of disparate worlds—'back' home (in Korea) and 'new' home and schools (in the United States)—with different cultural codes and discourses (Lew, 2006) and, extends Ogbu's theoretical frames of reference to interpret possible paradoxical acts in achievement gaps.

Korean, Korean-American, and American students are likely to have different sociocultural frames of reference. One major source of frame of reference is school curriculum and performance standards as well as teacher and parent expectations for students. TIMSS curriculum studies have showed that the U.S. curriculum is not only less focused, but also less advanced; the topics being taught in U.S. 8th grade math classrooms were taught at the 7th grade level in some high-performing countries such as Korea

(Schmidt, McKnight, & Raizen, 1997). For average Korean students who are expectedly all college-bound and under severe competitive stress, their frame of reference is more likely to be national high-performing student group based on high-stakes college entrance tests and feedback from private tutors in their college-prep cram schools; their primary goal is getting admissions to top-tier selective colleges and universities (Kwon, Lee, & Shin, 2015). For average American students who are not always college-bound and under less competitive pressure, their frame of reference is more likely to be local norms in their own schools based on school grades and teacher feedback (Lee, Liu, Amo, & Wang, 2014). For Korean-American students in the U.S., their frame of reference is likely to be dual (e.g., primarily American and secondarily Korean or vice versa depending on their identity and generation status), and thus performance expectation is intermediate between the average Koreans and Americans. Asian-American parents' expectations for academic performance tend to be generally higher than those of other racial groups (Thernstrom & Thernstrom, 2003), but their gaps relative to ones back in the home country are less well known and may vary by the origin of country and culture.

Frog-pond model has been usually studied in the organizational context of educational and occupational attainment, involving comparisons among high-performing students from high vs. low-performing schools. For example, college admissions studies weighed the importance of individual students' academic merit relative to their schools' average achievement for determining the chance of admissions to selective colleges. Previous studies found modest benefits of being positioned as a "big frog in a small pond" (i.e., high class rank) but at the same time there were counterbalancing effects of being regarded as a "small frog in a big pond" (i.e., high prestige of school reputation) (see Attewell, 2001; Espenshade, Hale, & Chung, 2005; Marsh, Koller, & Baumert, 2001). However, there is dearth of research on the frog-pond model in the larger sociocultural context of educational achievement through comparisons among high-performing ethnic groups from high- vs. low-performing nations. This transnational comparison would give new insights into multi-faceted achievement gaps among Koreans, Korean-American immigrants and Korean-American native students of the shared ethnicity who have different frames of reference and standards for academic achievement.

While our study focuses on cross-cultural differences between Korea and the U.S., it is worth noting that there have been significant educational policy changes in terms of high-stakes testing and academic pressure over the past two decades in both nations. In the U.S., the No Child Left Behind Act of 2001 (NCLB) mandated high-stakes testing across all states to hold schools and teachers accountable for students' reading and math achievement, while many states also adopted high school exit exams (Lee, 2016). In Korea, similar to the NCLB, the government enhanced test-driven school accountability, No Student Below Basic [Competency] (NSBB) policy since 2009 (Woo et al., 2015). While these policies in both nations were aimed at improving low-performing students, college entrance exams were more likely to affect middle/high-performing students. College admissions system in the U.S. remained highly decentralized and stratified in that students from different racial and socioeconomic backgrounds would have different access to diverse types of higher education institutions (Roksa, Grodsky, Arum & Gamoran, 2007). At the same time, college admissions system in Korea went through changes since the late 1990s, when colleges and universities began to consider the broader range of factors for admissions such as student's high school records, involvement in extracurricular activities, teacher recommendation, student's essays, etc. (Park, 2014). As more factors are considered for college admission

decisions, the influences of the high-stake exam, College Scholastic Ability Test (CSAT), have gradually decreased, which was originally developed to measure higher-level thinking abilities for college readiness. In spite of these changes, the burden of preparing for CSAT and other exams did not lessen among most students in Korea where college admission system continues to serve as a 'gatekeeper' of their success in life, in terms of entering an elite school or having a better career (Kwon, Lee, & Shin, 2017). While the recent trend of educational policies may bring more convergence between Korea and the U.S. in their education systems, those nations' underlying cultural and institutional differences are likely to shape the gaps in their students' attitudes and achievement.

Methods

The primary data used for this mixed-methods study drew on subsamples from the 2007 Trends in International Mathematics and Science Study (TIMSS) that provides math assessment and survey data for Grade 8 students, with focus on the two nations including the U.S. and Korea. This study also drew on subsamples from the Early Childhood Longitudinal Study-Kindergarten (ECLS-K) that provides math assessment and survey data for a nationally-representative U.S. sample of kindergartners from the fall of 1998 through 2007, with focus on Korean-American 8th grade students in 2007. The reason why we chose to use 2007 TIMSS data in particular (as opposed to more recent data) is due to the fact that it matches the ECLS-K data collection time (year 2007) for the same grade level (8th grade). Linking both TIMSS and ECLS-K data is crucial for this study, since (1) TIMSS allows for international comparisons (i.e., U.S. vs. Korea), whereas (2) ECLS-K allows for breakdown of the U.S. sample by ethnicity and generation status and thus U.S. domestic comparisons (i.e., Korean-Americans vs. other Americans).

Among the ECLS-K 8th grade Asian students, those whose self-reported ethnic identity was Korean were classified into two groups: immigrants (the first and second generation students) and natives (the third generation and plus). This generation grouping was based on the birthplace of students and their mothers (or fathers in the absence of mothers): If both students and parents were born in the U.S., then they were treated as natives. This study linked TIMSS 2007 8th grade math assessment/survey data and ECLS-K 2007 8th grade math assessment/survey data for comparing the 8th grade samples. As show in Table 1, our analytic sample includes Koreans (N = 4,240 in TIMSS), Korean-American natives (N = 14 in ECLS-K), Korean-American immigrants (N = 39 in ECLS-K), and Americans (N = 7,377 in TIMSS and N = 7,332 in ECLS-K). When 'Korean-American students' or 'Korean Americans' are referred to in this paper, the population denotes both Korean-American immigrants and natives combined in that these groups share Korean cultural heritage identity and its influence on their educational experience and achievement.

For measuring "Actual" Achievement Level (AAL), test score data were used. A linear linking (scale concordance) method was used to convert both TIMSS and ECLS-K math achievement test scores into National Assessment of Educational Progress (NAEP) scale, based on the assumptions of test and population comparability. There were commonalities between NAEP and TIMSS that enhance the validity of linking the scores. First, both NAEP and TIMSS were based on similar curricular frameworks; although the two assessments have no common items, content analyses of both assessments suggest that they are

Table 1. Description of the data: Sample size and descriptive statistics

	Koreans	Korean-American Immigrants	Korean-American Natives	Americans
Sample size (*N*)	4,240	14	39	7,377 (TIMSS) 7,332 (ECLS-K)
Data source	TIMSS 2007 8th grade data	ECLS-K 2007 8th grade data	ECLS-K 2007 8th grade data	ECLS-K and TIMSS 2007 8th grade data
% students whose parents have a college degree or higher	49	83	63	52
Average math achievement test scores (in TIMSS scale score)	603	570	543	509
% students who think that they do well or get good grades in math	44	78	73	83

sufficiently similar to warrant linkage for global comparisons (National Center for Education Statistics, 2006). The same can be said of NAEP and ECLS-K. Using the U.S. average as common anchor point between TIMSS and ECLS-K datasets, the aforementioned math achievement test scores were compared among Koreans, Korean-American immigrants, and Korean-American natives; the gaps were measured in standard deviation units relative to average American students (serving as common reference group).

For measuring "Perceived" Achievement Level (PAL), survey questionnaire data were used. The TIMSS survey question asked students to indicate the degree of agreement with a statement: "I usually do well in math." The percentage of students who rated themselves as good performers in math (i.e., choosing the response "strongly agree" or "agree") has been calculated separately for the U.S. and Korean 8th grade student samples. Similarly, the ECLS-K survey asked students to indicate the degree of truthfulness about a statement: "I get good grades in math." The percentage of students who rated themselves as good performers in math (i.e., choosing the response "very true" or "true") was calculated separately for the U.S. sample and Korean-American subsamples. Although the questions were not identical between the two datasets, both tapped into students' own perceptions of math achievement that would reflect their school grades and performance standards. The average self-ratings of math achievement were compared among Koreans, Korean-American immigrants, Korean-American natives, and American students (reference group).

The percentage of 8th grade students with college-educated parents was 49% for Koreans, 52% for Americans, and 69% for Korean-Americans (83% for immigrants and 63% for natives). To take into account the parent education differences of those groups, that is, a common indicator of family socioeconomic status (SES) that is available in both ECLS-K

and TIMSS datasets, the study matched student groups by their parental education level and examined adjusted gaps among the groups in their math achievement (1) AAL as measured by test scores and (2) PAL as measured by self-ratings.

Figure 2 illustrates how this study was designed to examine and compare actual vs. perceived achievement gaps between Korean, Korean-American, and American students. Given the hypothetical normal distributions of math achievement test scores for Korea (left-hand side bell curve) and U.S. (right-hand side bell curve) respectively, the average test score differences between Koreans and Americans are equivalent to the vertical distance between Yk and Ya points: Yk − Ya = Korea vs. US math test score gap. This gap calculation is based on the TIMSS 2007 8th grade math assessment data for Korea vs. U.S. samples. In a similar vein, the average test score differences between Korean-American students in the U.S. and all American students in the U.S. are calculated: Yka-i − Ya = Korean-American immigrant vs. average American gap, and Yka-n − Ya = Korean-American native vs. average American gap. This gap calculation is based on the ECLS-K 2007 8th grade math assessment data for Korean-American student subsamples relative to entire American student sample. Based on relevant theory and prior research, it is hypothesized that Actual Achievement Level in math (AALm) as measured by test scores follows this rank order: Koreans > Korean-American immigrants > Korean-American natives > Americans. We conducted pairwise comparisons with t-tests for the statistical significance of both unadjusted and adjusted (control for parental education) gaps.

On the other hand, we expect very different distributions of math achievement proficiency standards in Figure 2, that is, Desired Achievement Level (DAL) for Korea (left-hand side bar) and DAL for U.S. (right-hand side bar). The average proficiency standards/expectations differences between Koreans and Americans are equivalent to the vertical distance between Sk and Sa points: Sk − Sa = Korea vs. US math proficiency standard gap. Because the DAL gap is even bigger than the AAL gap between the two countries, their Perceived Achievement Level (PAL) gap is likely to become negative; (Yk − Ya) − (Sk − Sa) = Korea vs. US math self-rating gap. In other words, American students are likely to rate their performance higher than Korean students. In a similar vein, the proficiency standard differences between Korean-American students and average American students may cause relatively lower self-rating among Korean-American students. It is hypothesized that Perceived Achievement Level in math (PALm) as measured by self-ratings follows this rank order: Americans > Korean-American natives > Korean-American immigrants > Koreans.

The secondary data source for this mixed-methods study is six qualitative interview case studies conducted in spring 2020. Two Korean natives (one female and one male)—Jihyun and Minsoo, two Korean-American 1.5 generation immigrants (both females)—Naeun and Bora, and two Americans (one female and one male)—Sara and Ben--were recruited through convenience sampling to complement and illustrate, with the stories of their respective participation in the domestic and transnational educational ecological systems, the primary results from the quantitative analysis. The participants in the age range of 20's and 30's were college educated. The 1.5 generation Korean Americans arrived in the U.S. during their adolescence and experienced both Korean and American secondary education systems. Each of the one-on-one interviews, using the series of structured questions based on the emerging findings of statistical analyses, provided the participants with an opportunity to reflect and elaborate on their educational experiences regarding math achievement gaps.

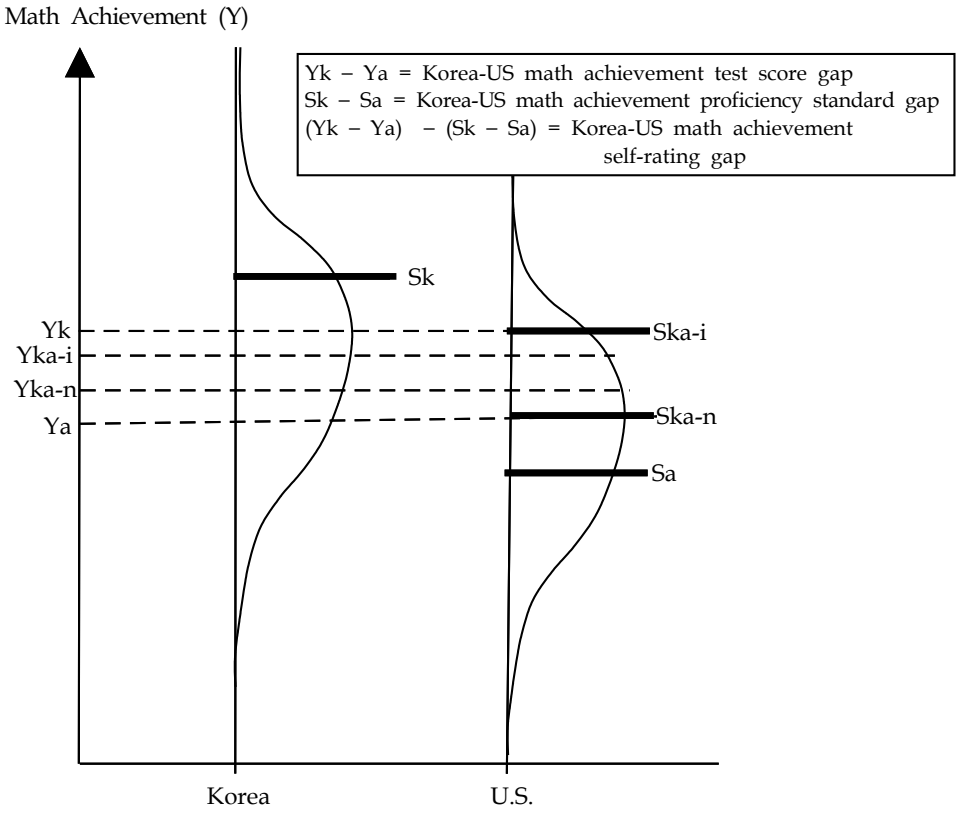

Figure 2. Illustration of hypothetical Korea-US math achievement test score and proficiency standard distributions

Note. Yk = Korea students' average math achievement test scores;
Ya = American students' average math achievement test scores;
Yka-i = Korean-American immigrant students' average math achievement test scores;
Yka-n = Korean-American native students' average math achievement test scores;
Sk = Korea students' average math achievement standard for proficiency;
Ska-i = Korean-American immigrant students' average math achievement standard for proficiency;
Ska-n = Korean-American native students' average math achievement standard for proficiency;
Sa = American students' average math achievement standard for proficiency

Results

Quantitative study findings

Figure 3 shows math achievement gaps in both test scores (black bar) and self-ratings (white bar) among Koreans, Korean-American immigrants, and Korean-American natives. For the sake of facilitating comparable interpretation on a common scale, all of the gap measures were reported in Cohen's effect size (*d*) metric; the average group score differences were divided by corresponding standard deviations for the U.S. sample (reference group).

For math test scores, Korean-American students, both immigrants and natives, perform significantly better than the average American students including White students as well as other racial and ethnic minority groups. However, the Korean-American vs. average American math achievement gap within the U.S. is much smaller than the gap between the U.S. students and the Korean native students. Specifically, the Korean-American vs. average American achievement gap (0.66σ) in Grade 8 math based on ECLS-K 2007 data is about half of the gap between American students and Korean students (1.25σ) in Grade 8 math based on TIMSS 2007 data; both gaps are statistically significant, while one gap—American vs. Korean--is significantly greater than the other—American vs. Korean-American achievement gap (see Figure 3). When Korean-American students are further classified into immigrants (1st and 2nd generations) vs. natives (3rd generation and above), it turns out that immigrants perform better than natives (0.78σ vs. 0.43σ).

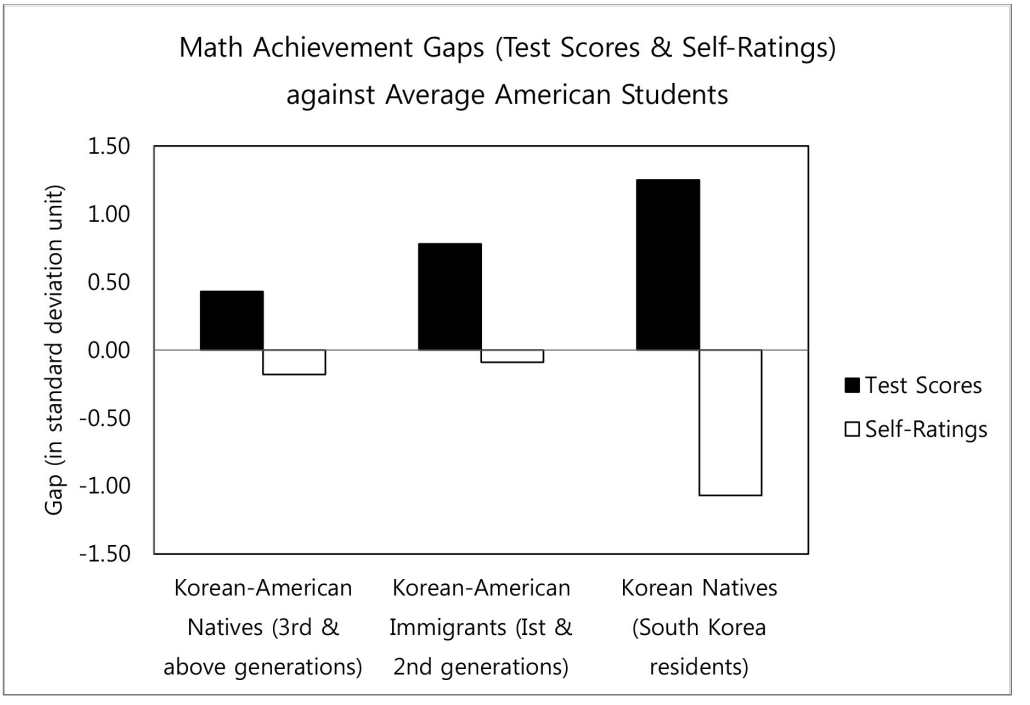

Figure 3. Math achievement gaps in test scores vs. self-ratings among Koreans, Korean-American immigrants, and Korean-American natives relative to average American students

Once we matched the samples by parent education level, the test score gaps did change somewhat, but the rank order of these groups' performance remained same (see Table 2 for the comparison of unadjusted vs. adjusted test score gaps). After controlling for parent education level, the achievement gap between Korean and American students gets slightly larger (1.34σ), whereas the test score gap between Korean-American immigrant students and average American students gets smaller (0.62σ) and the gap between Korean-American native students and average American students also gets smaller (0.36σ); this change reflects relatively higher level of parent education among Korean-American students.

Table 2. Actual and perceived math achievement gaps relative to Americans: Statistical tests of unadjusted and adjusted (Control for parental education) Gaps

	Koreans	Korean-American Immigrants	Korean-American Natives
Test score gaps (unadjusted)	1.25***	0.78**	0.43**
Test score gaps (adjusted)	1.34***	0.62*	0.36*
Self-rating gaps (unadjusted)	-1.07***	-.09	-.18
Self-rating gaps (adjusted)	-.95***	-.38	-.48**

Note. * $p < .05$, ** $p < .01$, *** $p < .001$
All of the gap measures above are reported in standard deviation units for common scale comparisons. Positive values indicate overperformance, whereas negative values indicate underperformance relative to the average American students as reference group.

On the other hand, it turns out that Korean pursuit of high academic standards and overachievement takes a toll on their academic self-concept (PALm). Only 43.5% of Korean 8th grade students reported that they usually do well in math, whereas 83.3% of American 8th grade students said the same. As shown in Figure 3, the gap was negative in direction and large in size (-1.07σ). Similar pattern of the opposite gap, albeit to a lesser extent, was observed between Korean-American students and average American students. In the U.S., 68.5% of American 8th grade students said that they get good grades in math, whereas 63.2% of Korean-American 8th grade students said the same; the gap between the two groups was also negative but small (-0.11σ). The difference between immigrants and natives among Korean-Americans was also relatively small; 64.3% of Korean-American immigrants reported that they get good grades in math (-.18σ), while 60% of Korean-American natives did so (-.09σ). Once we matched these groups by parent education level, the self-rating gaps changed a little but the rank orders among the groups remained the same (see Table 2).

Overall, as shown by Figure 3 (see the contrast of black bars for test scores vs. white bars for self-ratings), the pattern of self-rating gaps among these groups in perceived math achievement is somewhat oppositional to the pattern of corresponding test score gaps in actual math achievement; the bars rise above or below the horizontal reference line of zero (i.e., gap relative to Americans as reference group), depending on whether the gap is about perceived vs. actual achievement. Indeed, it is paradoxical that the rank order patterns of math test score gaps vs. self-rating gaps among Koreans, Korean-Americans and Americans tend to follow the mirror images of each other. Those test score gaps and self-rating gaps are only partially attributable to family socioeconomic status (SES) differences among groups.

Qualitative study findings

Here, we introduce select stories of our interview participants to help understand the internationally comparative achievement gap patterns according to our hypotheses illustrated in Figure 2. First, the lived experiences of Naeun and Bora—two Korean Americans in their 20's and 30's respectively—in two different educational ecological systems provide helpful illustrations to understand individuals' math achievement gaps in terms of test scores (AALm), self-ratings (PALm), and proficiency standards (DALm). Naeun and Bora started their secondary education in Korea (like other native Koreans) and completed it in the U.S. (as 1.5 generation Korean-American immigrants). While in Korea, Naeun's AALm was at 60 to 80%. Considering the higher math achievement proficiency standard in Korea (DALm) than her AALm, Naeun was "always under pressure" and felt that she "did not do well" (negative PALm) in "strict" math classes. Bora's math learning experience in Korea was similar to Naeun's in that the curriculum standard (DALm) was high and "not easy". Given the her AALm at grade F's, Bora often found herself "totally lost" and feeling "alone" in math classes. She 'strongly disagreed' (negative PALm) to the given statement about her math performance: I did well in math. Bora attributed her failure in math performance to Korean cultural expectation to "be in a certain grade or being a good student" (meaning high-achieving student), competitive peer culture not to lose face, and differentiated treatment, and pressure from teachers and parents.

Then, notable changes happened to Bora and Naeun at the onset of their immigration to the U.S. with a different educational system and a lower proficiency standard than before. Their resulting experience came with high-performing math grades typically in the range of A (Naeun) and B (Bora). Understandably, both of them 'agreed' (positive PALm) to the statement: "I did well in math" in American schools. Comparing to her math class in Korea, Naeun reflected on her early experience of the American math class regarding the different, lower achievement proficiency standards (new DALm) as follow:

> One thing that's for sure is that the level of difficulty is totally different. In Korea, the stuff [math curriculum] that you learn in elementary school is stuff that you learn in middle school but in U.S. It's a lot different because when you came here [U.S.] and started at the seventh grade, they were learning stuff that I had already learned years ago, so it was easy for me.

Such changes in AALs, PALs, and DALs and statuses from a "small frog in a big pond" to a "big frog in a small pond" were not the output of some learning in their new schools in the U.S. in that the changes were not gradual or developmental but sudden and instant. These Korean immigrants living with dual culturally different frames of reference experienced the effect of dynamic, transnational sociocultural ecologies of standards and expectations.

Additional insights on the multi-faceted nature of the achievement gap phenomenon are illustrated in the stories of the other Korean and American participants. Minsoo, native Korean in his 30', is easily considered to be the typical high-achieving performer in that he was accepted to a highly selective, nationally competitive high school, admission to which was given only to top 3% achievers of the school. Despite the high AALm, Minsoo's individual goals (DALm) seemed even higher than those of Naeun's and Bora's because he was competing with nationally-selected talents whom he called "geniuses" in order to score

well in the high-stakes College Scholastic Ability Test and eventually enter a prestigious university in Korea, which, indeed, he accomplished. If he ever had questions about math problems, Minsoo would ask his higher-achieving peers in his class. Compared to his genius friends, his AALm was "just middle" and he put his best "efforts" investing most self-study time in math in his boarding school every day from 6 am to midnight to manage the math achievement gap at a positive level. With regard to his transition to the competitive high school with nationally selected high-ability students, Minsoo reflected on DALm, AALm, and PALm as follows:

> I went to some competitive high school and that high school [had] a lot of competitive students from the nation… I can say I'm quite good at math…If I compare to those [high-ability students], I'm not good at math. I'm sure that I'm not a genius…they look like a genius…I put a lot of time and I put a lot of efforts.

The story of the other Korean native Jihyun in her 20's is not different from Minsoo's. In order to reach top 4% (DALm) of her school, she participated in the school-mandated study hall hours until 10 pm to work on her math. In addition, she chose to attend a private after-school math academy, which Minsoo went every weekday during the middle school as "most of students go" as cultural community practices.

A noteworthy contrast to the math achievement stories of Korean and Korean American students was found in those of White American students in their 20's, Sara and Ben, both achievers of the math grade range of A and B. Although their school grade trouble threshold was B-, the pressure level from parents was not comparable to what Korean and Korean American students lived under. Ben only needed to "get through it" (DALm) as he "thought [he] did good enough" (PALm) due to his "natural ability". Considering the relatively lower standards, compared to Koreans and Korean Americans, Ben "did well without putting in lot of effort". In Sara's case, although "there was very little actual [one-on-one] engagement in the [math] class", still she was able to find opportunity to learn during school study hall hours to ask her math teacher on math problems and also at home with her parents who helped her math homework. Differently from the Korean and Korean-American participants, Sara's frame of reference was less communal than individual; she wanted to level her math grade up to the higher-ability level as in other subjects.

Discussion

Our study contributes to advancing more fine-grained and nuanced understanding of racial and ethnic achievement gap problems by integrating the analyses of domestic achievement gaps (e.g., Korean-American immigrant vs. White-American achievement gap), international achievement gaps (e.g., Korean native vs. American achievement gap), and transnational achievement gaps (e.g., Korean native vs. Korean American achievement gap). Our study also helps inform more comprehensive and balanced educational policy to tackle achievement gap problems by integrating the analyses of both academic achievement and self-concept. These analytic approaches together challenge the monolithic view (and myth) of Korean students including Korean natives and Korean-American immigrant and native students. In spite of American education policy efforts for improving all students' college

and career readiness, the policy tends to focus on the needs of low-achieving racial minority groups but may ignore so-called model minority groups such as Korean-American immigrant and native students while often equating them with Korean natives. We would discuss the key research findings, implications and limitations below.

Our comparative analysis of actual vs. perceived math achievement among Korean, Korean-American immigrant and Korean-American native students suggests that observed group differences in achievement test scores vs. self-ratings reflect the confluences of cultural and institutional forces. In terms of actual math achievement as measured by standardized test scores, it turns out that Korean students perform significantly better than Korean-American immigrant students who in turn perform better than Korean-American native students. Korean-American students' math achievement is intermediate between native Korean students and American students. Korean-American native students were more similar to typical American students than to typical Korean students in terms of math achievement test scores. In contrast, Korean-American immigrants are more similar to typical Korean students than to typical American students in math test performance. Despite having similar cultural background characteristics and relatively lower level of parental education, Korean students perform significantly better than the Korean-American immigrants whose parents or who themselves were born in Korea.

Further, high Actual Achievement Level in math among students with Korean heritage is attributable to multiple cultural and institutional factors. The list of high-impact cultural resources includes Korean 'cultural-ecological environment' (Ogbu & Simons, 1998) in society at large and also within family and community to value and support academic excellence, in particular, high achievement in math as one of the college readiness determinants on the Korean college entrance exam, prestigious schools with high-ability students, school-mandated extended study hall hours, competence-based competitive peer culture and social capital, and private after-school math academies. Sharing Korean cultural heritage is not merely biological asset to be endowed. Along with individual ability, all of the Korean-style high-impact cultural, institutional, and social resources contribute to raising Desired Achievement Level (DAL) and Actual Achievement Level (AAL) and also to increasing Opportunity to Learn (OTL) and Engagement to Learning (ETL) (see Figure 1; for more details, Lee, 2016). The ultimate goal of Achievement Gain (Realized Growth) is socially constructed through building and participating in individuals' repertoires of cultural practice (Gutiérrez & Rogoff, 2003) for math achievement, college and career readiness, individual social mobility, and communal prosperity. Moreover, the washed-away social structure (Wang & Lin, 2005; Zhou & Kim, 2006) of the education fever culture of origin transgresses national boundaries and reshapes the transnational worlds of Korean Americans living with Korean-American dual standards.

On the contrary, in terms of perceived math achievement as measured by students' self-ratings, Korean students have significantly lower self-concept than Korean-American (both immigrant and native) students. It is worth noting that among Korean-American students, there are no significant differences in perception but significant differences in test scores by immigration generation status. The findings imply that Korean students are more like a "small frog in a big pond" as in the cases of Minsoo and Jihyun, whereas Korean-American students are more like a "big frog in a small pond" as illustrated in Naeun's and Bora's stories of this study. High academic expectations and pressure seem to play a double-edged sword role for students' academic achievement and self-concept. There are no clear winners, since the dynamics of a small frog in a big pond vs. a big frog in

a small pond may have counterbalancing effects. Moreover, in spite of high academic performance on average, both Korean and Korean-American student groups would need psychological help with self-concepts; they may struggle with the stereotype threat of 'model nationality' or 'model minority' in terms of educational success.

Subsequent studies also need to examine long-term effects and implications of students' actual vs. perceived achievement gaps in terms of their future college and career success. In contrast to the U.S., competition for top-tier college entrance is more intense and starts much earlier in Korea where after-school private tutoring practices are prevalent (Lee, 2007). This kind of college test prep and tutoring practice tends to replicate among Korean-Americans, albeit to a varying extent by family SES (Teranishi, Ceja, Antonio, Allen, & McDonough, 2004). In light of education policy changes in both Korea and U.S. over the past decade, we need to explore further what types of contexts constitute 'big pond' vs. 'small pond' from an international perspective and also what levels of aspirations define 'big frog' vs. 'small frog' from a transnational perspective. For example, let us imagine comparing Korean vs. Korean-American students, one who studies for CSAT to enter Korea's top-tier college vs. another who studies for SAT/ACT to enter America's Ivy League college. Which student is more likely to realize his or her dream as a "small frog in a big pond" vs. a "big frog in a small pond"? It depends on how different framing and positioning affect the student's learning goals, attitudes, efforts, and outcomes.

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